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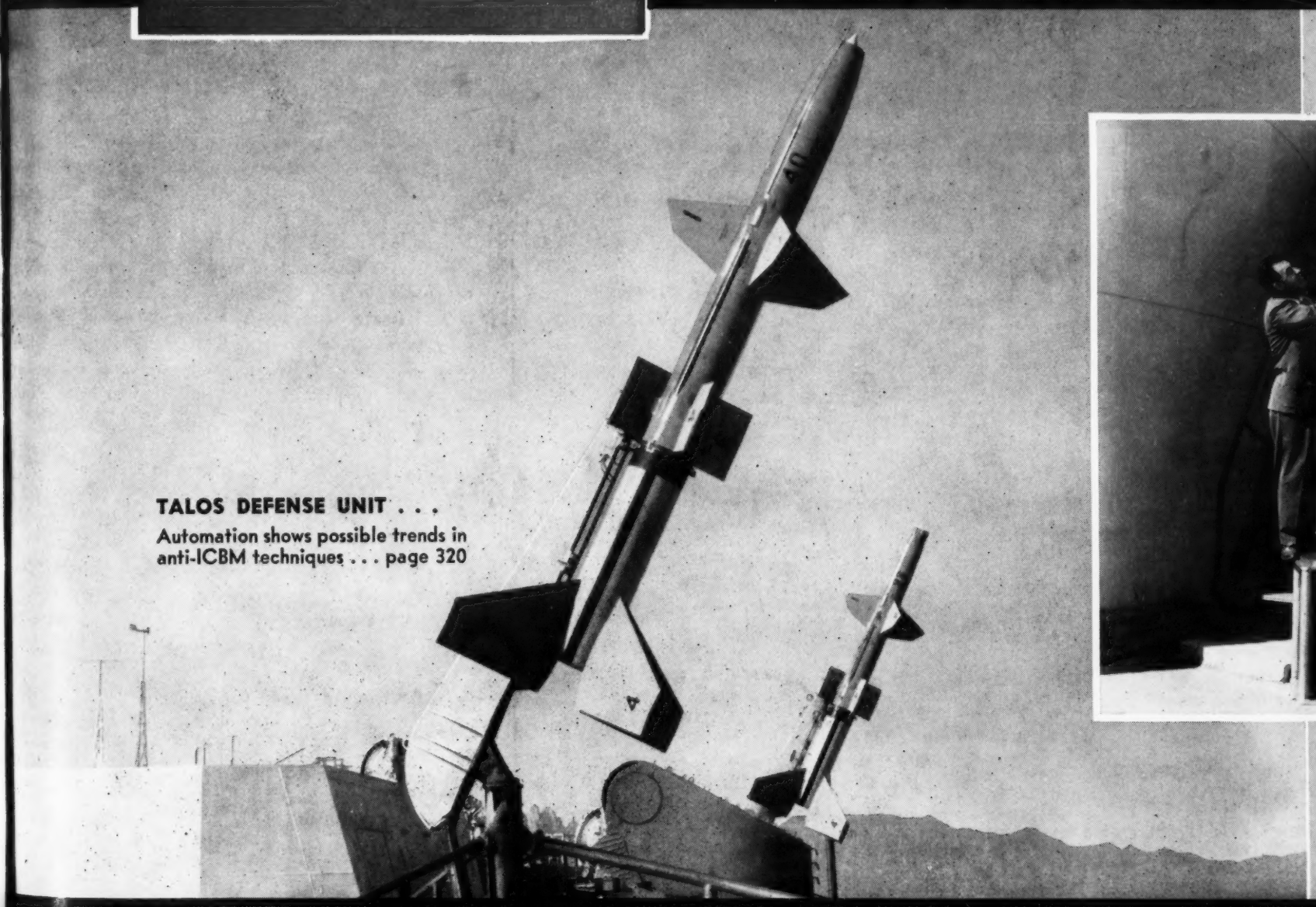
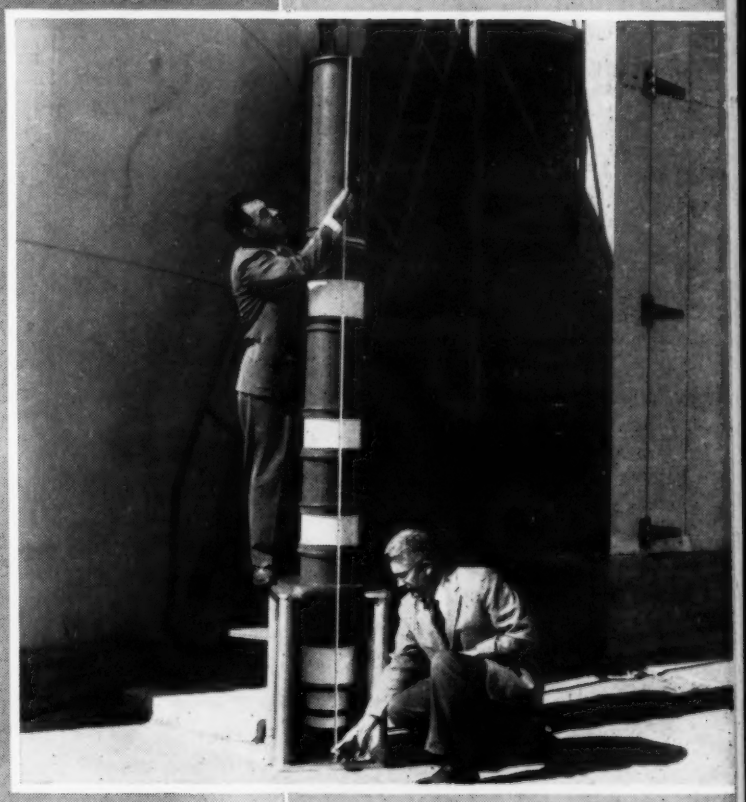
MA

military automation

NOVEMBER-DECEMBER 1957



TALOS DEFENSE UNIT . . .
Automation shows possible trends in anti-ICBM techniques . . . page 320



GIANT KLYSTRON . . .
generates peak output of over 1250 kw . . . page 308

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In This Issue

We feature current applications of that versatile UHF oscillator and amplifier, the klystron; the recording of television programs (and other broadband data) by the magnetic Videotape method; the application of completely automatic tactical controls to the aiming and firing of the land-based Talos missile; and a pictorial article on the training methods and instructional aids used in Nike training classes at the Army's AAA&GM School, Fort Bliss, Texas.

Our printed circuit series illustrates how methods and techniques previously introduced are being applied in typical manufactured circuits. The direct method of attenuation measurement is given in our second article on microwave theory and techniques. Our newest continuing feature, Circuitry for Military Applications, provides step-by-step analysis of the operation of two typical phantastron circuits and a cascode amplifier.

Featurettes describe a new automatic Flare Landing System for missiles and aircraft; a short-cut method for illustrating technical reports (Pre-screened Diazo Pix); aircraft instrument panel research; a French-developed air navigation and anti-collision system; and the new DuMont black-background Cathode Ray Tube. Reduction of radar video into narrow-band form to allow transmission over a radio-relay link, and the Stromberg Carlson—Haloid high-speed computer printout—are also reported.

Our readers have indicated that the New Products section and the New Literature are invaluable to them in keeping abreast of new commercial developments. This issue contains more of these items over a wider range of applications than we have regularly carried.

With this issue we also step up to 30,000 circulation. Conservatively estimating four readers per copy, this means that 120,000 fellow readers are sharing this important information with you! Glad to have all of you aboard!

MA "Subscriptions"

Military Automation is mailed without charge to qualified applicants who follow the instructions provided on page 302, at their business addresses. No mailings outside the United States, except to military post office numbers, will be made. Back copies cannot be furnished, and articles will not be reprinted except in orders for 100 or more, for which the actual cost of reprinting will be charged.

Mailing may be made to a military billet address in lieu of a name, if the application form is signed by or at the direction of the commanding officer of the activity. A description of the billet duties must be given to assure circulation auditors that the recipient is a qualified addressee. Application forms, properly executed and signed, are equivalent to money payments for subscription type magazines, and your care in filling out the questions asked is respectfully requested.

MA

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NOV.-DEC.

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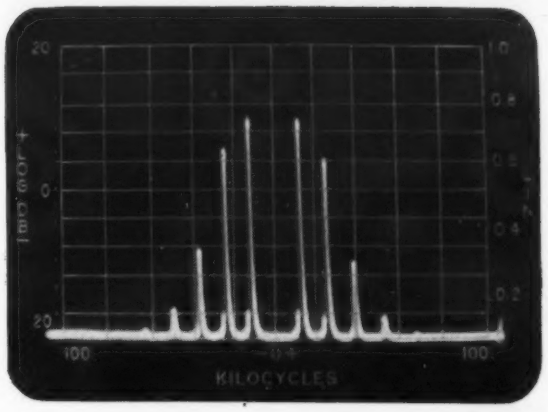
FM Deviation Check
4.3 kc. modulation at first carrier null.

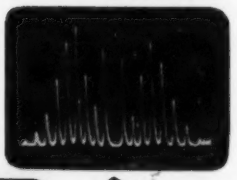
Deviation = ±10.32 kc. Panoramic display shows actual sideband spread including those beyond deviation.

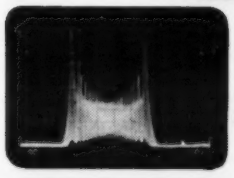


FM problems?

pictures like these give the answers you need for FM operating and equipment testing

Two photos showing FM signals of equal deviations (±55.2 kc) but different energy distributions. FM deviation monitor would read identically in both tests.





10 kc modulation at second carrier null

Same modulation level—frequency 1 kc

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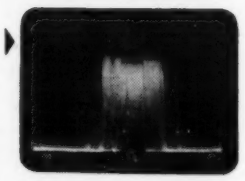
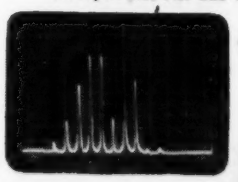
- Determine sideband spillover . . . assure conformance with statutory bandwidth restrictions of sideband energy
- See RAPIDLY the frequency vs amplitude contents of FM signals . . . compare relative magnitudes of FM frequency components
- Measure deviation precisely through carrier and sideband nulls
- Observe clearly sideband structure under complex forms of modulation
- Analyze carrier shifts, incidental AM, hum, RF harmonics non-linearities . . . detect carrier pulling or instability in both magnitude and direction
- Adjust operating parameters at optimum

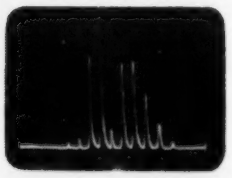
Major regions of FM system sideband energy due to speech modulation clearly illustrated on Panalyzor. Slow scans aid in visual appreciation of average envelope. Extended exposure photographs also are valuable for complex wave analysis.



Two photos; FM due to clipped sine wave



Relative lack of sidebands to left of carrier (centered on Panalyzor screen) indicate limited deviation on clipped end of oscillator swing.



Here the other side is clipped. Note mirror image effect and slight carrier shift.

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Editor, MA:

I want to thank you for MILITARY AUTOMATION. I think it is terrific. It has a lot of information on things I ought to know more about but just don't have time to keep up on. The articles are clearly written, and they're "broken down into little pieces" for better understanding.

The last edition of MA I have seen is the July-August issue. Would appreciate very much if you could put me on your list for the recent ones.

E. K. Price
General Precision Laboratories
Pleasantville, N. Y.

Your comment on the understandability of MA is a real compliment to us, because we make a sincere effort in our writing and editing to produce articles that say things simply and plainly.

Editor, MA:

In your July-August issue on page 212, the Elgarol Process of printing is mentioned. We would be very interested in knowing about this process, and also about any other information on the formulation of resistor and conducting inks.

Phillip S. Duke
Solar Manufacturing Corp.
Los Angeles, Calif.

You can receive full data about the various inks and the Elgarol Process from Mr. George R. Stewart, J. Frank Motson Co., 1717 Bethlehem Pike, Flourtown, Penna.

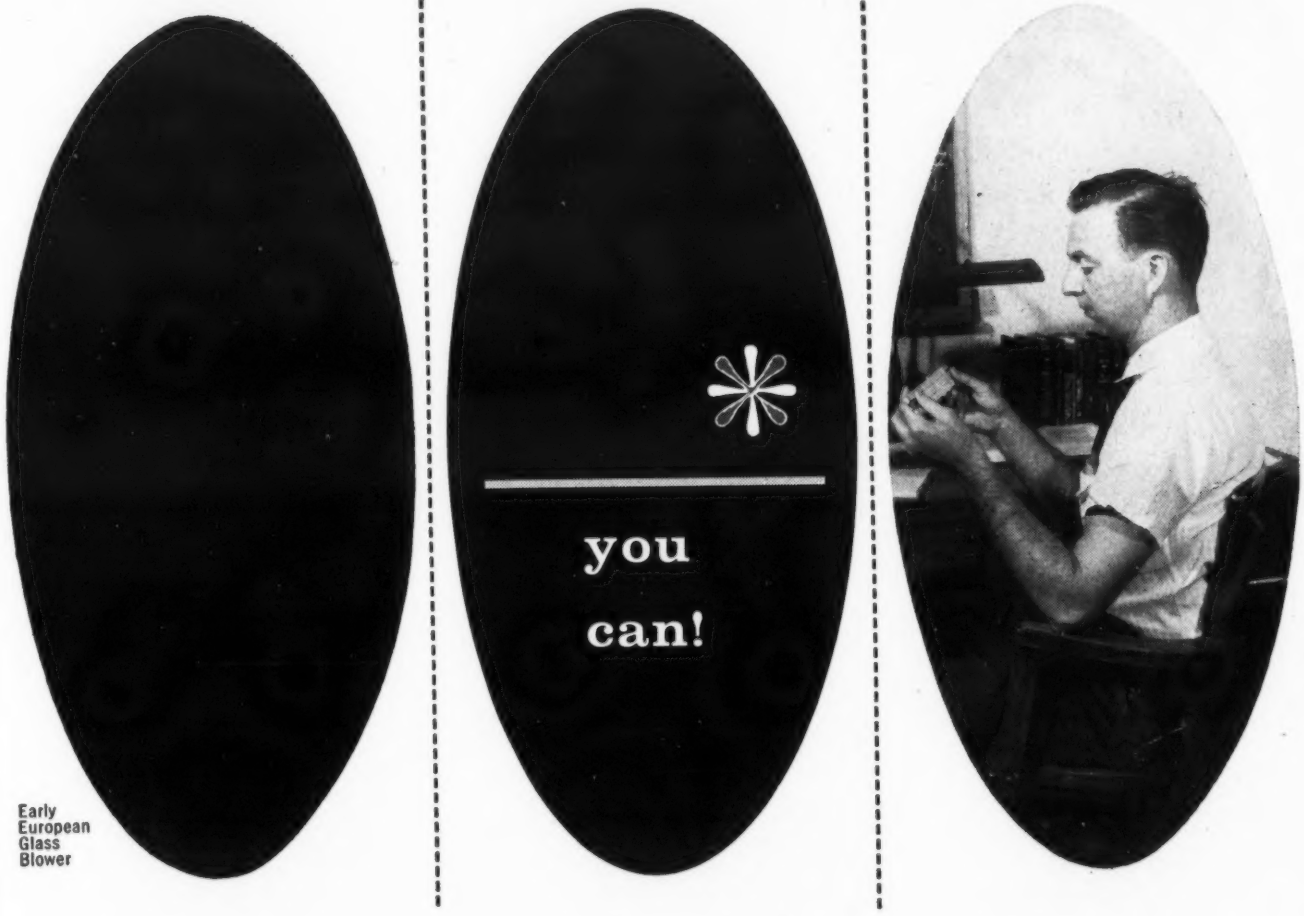
Editor, MA:

I read with great interest the series of articles on Digital Computers which appeared in the January thru June issues of MILITARY AUTOMATION. I would like to obtain reprints of these articles for use as study material in a course on Digital Computers to be given to junior engineers and technicians. Kindly advise if reprints are available.

A. Sicuranza
So. Farmingdale, N. Y.

The MA series on Digital Computers was an abridgement of a longer series which was currently appearing in our sister publication, INSTRUMENTS and AUTOMATION. The first eight installments of that series have been reprinted in a booklet which is available at $1.00 a copy. We believe you would find it excellent for class use because it covers the fundamentals of digital computers and their circuits. Also, the entire series (21 installments in all) will be published as a book in January, 1958, which will be announced in our Jan-Feb issue. Also, note the announcement of *Printed Circuitry* by Allan Lytel on page 336.

Continued on page 306



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LETTERS —CONTINUED

Continued from page 303

Editor, MA:

Congratulations on the handling of the Bell Automatic Landing System story. It was beautifully done . . . . your pictures were excellent.

Selma Warner
Reeves Instrument Corp. Div.
Dynamics Corporation of America

Editor, MA:

Varian Associates very pleased with your presentation of Russell Varian's article in Sept.-Oct issue of MILITARY AUTOMATION. Please furnish earliest delivery date for 2000 reprints.

Donald A. Rutledge
Varian Associates
Palo Alto, Calif.

We were pleased to supply the reprints in time for distribution at the dedication of the new Varian Associates plant additions, Nov. 15. The new facilities are very impressive. Our warmest congratulations to Varian Associates on their expansion.

CORRECTION

The following credit line was inadvertently omitted from the heading of the "Synchros" article, page 274 of the September-Oct issue:

"Table I and Figs. 1, 2, 4. 5, 8, 9, and 10 are from the Norden-Ketay Corporation brochure, *Synchros for Data Transmission and Control Systems*, and are reproduced by courtesy of the Norden-Ketay Corporation."

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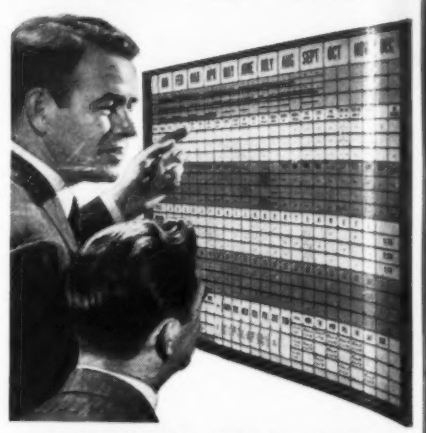

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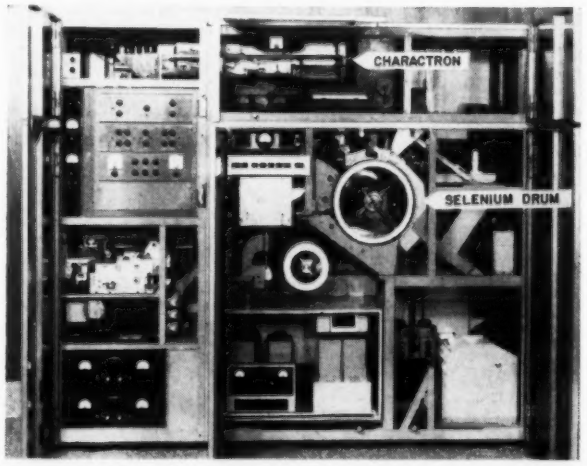
World's Fastest Printout

ROCHESTER, N. Y.—Modern computing devices have been capable of speeds far in excess of existing capabilities of men to supply them with data or to publish their results. Two recent developments, both featured in MILITARY AUTOMATION pages in the last six months, have now been teamed to produce an outstanding breakthrough in readout technique. These are: the new Stromberg-Carlson S-C 5000 high-speed Electronic Printer which combines the Charactron[1] shaped beam readout tube (May-June issue), and the Haloid Xerox[2] Copyflo[2] printer (July-August issue) to turn out printed copy at a rate of 85,000 words per minute—five to ten times faster than the highest printing speeds previously available for new material.

An electron beam, extruded through microscopic openings in a matrix, produces brilliant alpha-numeric characters on the phosphored face of a 7″ Charactron shaped-beam tube, at 4,680 lines per minute. These are optically projected onto the electrically charged surface of a selenium drum which is sensitive to light. Pigmented plastic powder is first picked up by the drum, then transferred to 11″-wide plain paper, gummed label stock, vellum or offset masters. Heat fuses the plastic to dry permanent characters, with the finished product spewing from the printer at 65 lineal feet per minute, in neatly-trimmed sheet form ready for binding.

The S-C 5000 printer is compatible with a wide range of computers, using either on-line or off-line inputs, through appropriate translating circuits. Off-



line methods will probably be favored in commercial applications such as the preparation of bank statements, billings, insurance notices, and address labels (one-million per eight-hour day). High-speed communications reception is a "natural", also the reception of weather map data.

Scientific and military uses, including the readout of complicated mathematical computations, reduction of missile and aircraft test data, and reception of air-traffic control data, will probably use on-line operation direct from computers to save precious time in the read-out stage. Simultaneous photographic recording of the Charactron image is possible. Multiple copies of printed reports can be readily obtained by re-running the input tape as many times as required, or by multilithing from masters initially prepared on the S-C 5000 Printer.

The noise usually associated with printing processes, particularly of high-speed types, is conspicuously absent because no high-speed moving parts are used in the printer. The heat generated by the fusing elements is readily removed by simple ventilating fans, and no air-cooling is needed for its operation.

Both primary components of the S-C 5000 have been field tested in military applications by the Stromberg-Carlson Company and by The Haloid Company, holders of the basic patents. The printer will be marketed by the Stromberg-Carlson Company, Rochester, N. Y., which is now accepting orders for delivery in six to nine months.

[1]Charactron is the trademark of the Stromberg-Carlson Company, a Division of General Dynamics Corporation.
[2]XeroX and Copyflo are trademarks of The Haloid Company.

For additional information on S-C 5000 Printer circle **201** on inquiry card.

MA EVENTS

January 6-8, 1958

Fourth National Symposium on Reliability and Quality Control at Statler Hotel, Washington D. C. Write W. M. Rombach, Chief Quality Control Engr., Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa.

January 27-30, 1958

163rd National Meeting of American Meteorological Society Barbizon-Plaza Hotel, New York City. Write Exec. Sec., 3 Joy St., Boston 8, Mass.

March 16-21, 1958

4th International Atomic Exposition sponsored by AICHE, ASCE, AIME, ASME, and AIEE; at Chicago, Ill. Write Atomic Exposition, 117 S. 17th St., Philadelphia 3, Pa.

March 17-21, 1958

Fourth Nuclear Engineering & Science Conference, and Atomfair of the Atomic Industrial Forum, Chicago International Amphithreatre. Write Joel Henry, Congress Mgr., American Institute of Chemical Engineers, 25 W. 45 St., New York 36, N. Y.

March 23-29, 1958

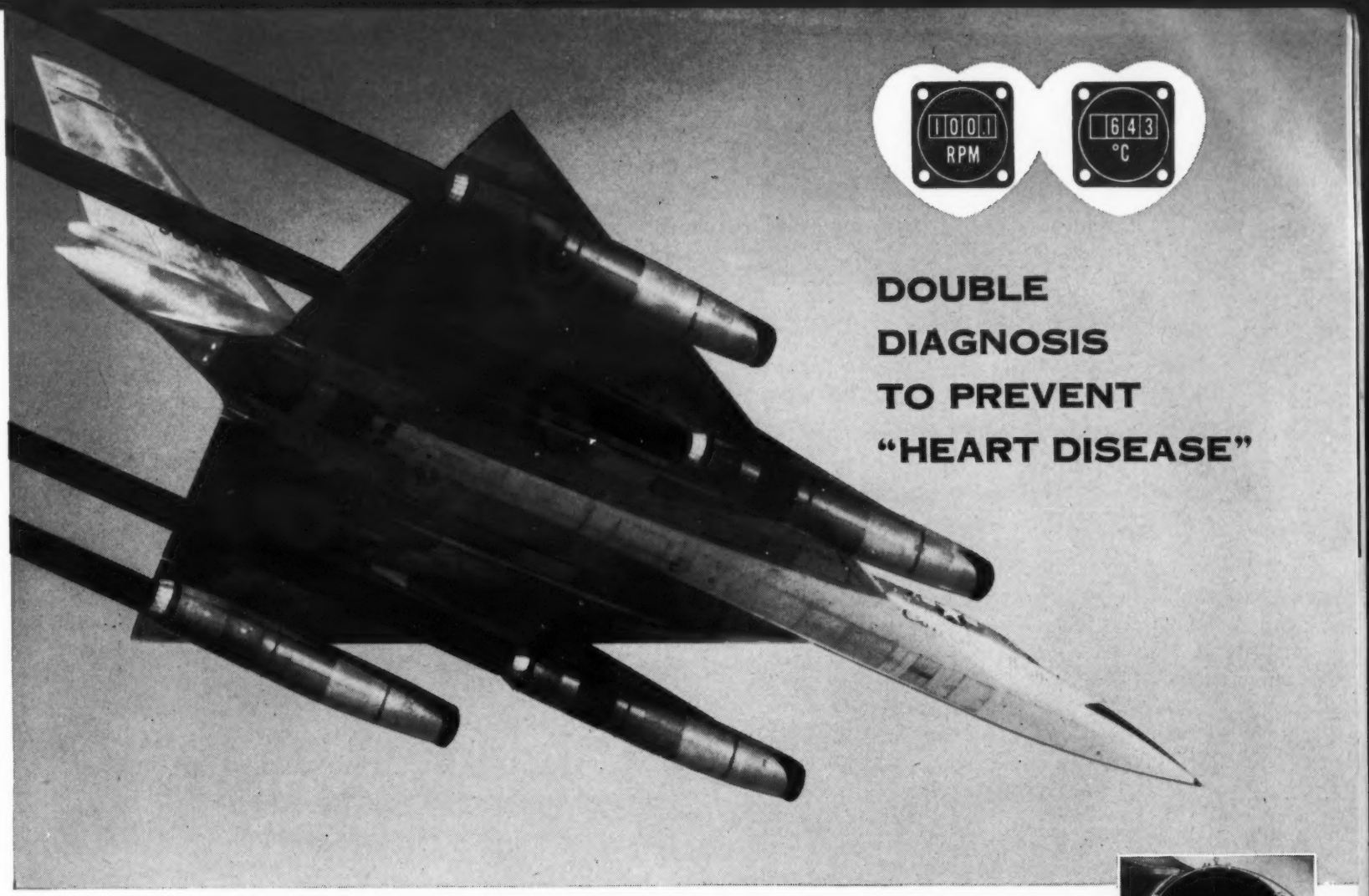
American Congress on Surveying and Mapping, and American Society of Photogrammetry Convention, Shoreham Hotel, Washington D. C. Write ACSM-ASP, 1515 Massachusetts Ave., N. W., Washington, D. C.

April 22-24, 1958

Electronic Components Conference at Ambassador Hotel, Los Angeles, Calif. Write E. E. Brewer, Zone 6-30, Convair, Div. of General Dynamics Corp., Pomona, Calif.

June 9-13, 1957

Fourth International Automation Congress & Exposition and First Military Automation Exposition, Coliseum, New York. For information write to Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.



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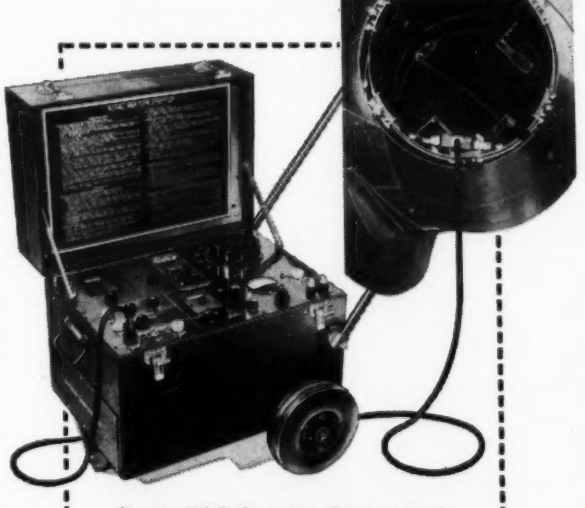

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Race With Catastrophe

In 1920 H. G. Wells said in his *OUTLINE OF HISTORY*, "More and more civilization becomes a race between education and catastrophe." His observation has recently been given an urgent interpretation by the latest Russian missile developments, as we now realize that the Russian system of incentives and training of engineers and scientists has been successful in bringing their military capabilities abreast of our own in a remarkably short time.

An examination of the Russian system of incentives shows that by stressing the financial rewards to scientists and engineers (in relation to other members of the Soviet economy), by giving them considerably more freedom (in a highly regimented population), and honors and privileges second only to high Party officials, most Russian youngsters now admire, and many aspire, to scientific learning. With this popular endorsement, emphasis toward scientific training and progress at all levels of schooling naturally follows. Pupils who show ability in scientific training are provided with free schooling up to the limit of their ability or to the graduate level. In comparison, it has not been many years since American scientists were regarded as "egg-heads," and not entirely above suspicion. Today engineers and research scientist salaries are considerably below other fields which require less training. A recent attitude survey among high school students revealed that few boys wanted to become scientists, thought of their work as dull, uninteresting, and poorly paid. The girls said, "No one wants to be a scientist or to marry him." Above the high school level, American education requires substantial financial sacrifice on the part of the student or his parents. Our leading technical schools have announced that the tuition costs are to be increased in the future, and that they expect to be more selective in their choice of applicants. They do not expect to enroll greater numbers of prospective scientists and engineers.

We do not draw this comparison as an argument that the U. S. must follow methods of Russia in order to survive. Actually, Russia has applied capitalistic methods to achieve her goals with a fine disregard of classical Communistic dogma. We can supply incentives and a practical method of making the training accessible to the prospective scientists, without departing from democratic practices.

Initially, incentives must stem from good salaries for experienced engineers and research scientists. The importance of the military defense program and scientific research activities will do much to increase the demand for able scientists. Every opportunity should be used to publicize the work that scientists perform and the glamor and romance that often is a large part of the reward of a career in science.

Federal Assistance to Scientific Training

Federal Aid to Schools, apparently blocked by considerations other than the need for better schools, is not the only method of increasing our output of scientists. A slight modification of the Veteran's Educational benefits program, administered by a board of scientists somewhat along the lines of the Smith-Hughes Vocational Education Act, with careful restrictions as to the programs supported, would enable capable students to attend existing colleges with a minimum of regulation and red tape. Similar programs are now being administered by the Navy in its NROTC Contract program at over forty colleges. No control over terminal employment need be attempted. If the best jobs available for such trained personnel are not in the scientific field, the need for scientists would evidently have been over-estimated.

Such a plan would be flexible and could be made available first at the higher levels of graduate study, then at lower beginning levels until the desired numbers of students were enrolled in the program. If the scientific training program were made attractive enough, improved curriculums which would qualify high school pupils for admission could be a powerful incentive toward the up-grading of preparatory school programs.

Preparatory Schools

Education at the preparatory level also needs careful attention. President Eisenhower stated in a recent address: "Remember that when a Russian graduates from high school he has had five years of physics, four years of chemistry, one year of astronomy, five years of biology, ten years of mathematics through trigonometry, and five years of a foreign language." If American students entered college with this level of preparation they could assimilate scientific training more rapidly. Recent TV programs show that our public relations experts are already at work, "selling science" to teen-agers.

Once the demand for science training at the high-school level has been aroused it can be satisfied on a crash basis by special classes or summer school courses available to applicants who demonstrate an ability to profit from it. Also the reorganization of present grade and high school curriculums can provide a much higher level of scientific and mathematical training.

However, it is not necessary to train the entire population in order to bring the gifted few out as top research personnel. It can be done more quickly and at much less expense by limiting the technical training to applicants who show by tests that they can assimilate the training. Federal funds applied selectively for those programs deemed most necessary will go farther than applied on an all-pupil basis.

Incentives and Training for Teachers

A shortage of adequately trained teachers may be the greatest obstacle to the timely training of technical personnel. Here government help for teacher salaries, again patterned on Smith-Hughes experience, may be necessary. In addition to adequate remuneration for essential services, other inducements may help ease the teacher shortage by restoring some of the prestige teachers once enjoyed. Mr. Richard Rimbach, publisher of MILITARY AUTOMATION, reported after a recent visit to Europe that German scientists and industrialists are frequently asked to lecture in the universities and schools. When so chosen, they are addressed by the title of " Professor Extraordinary," which is a considerable honor. Similar respect is also shown the regular teaching staff. Another stimulus to teachers of science and mathematics would be for the government to underwrite refresher training for them, as well as for their students. Schooling expenses for teachers also might be made a deductible income tax item. This should not create any great deficit in tax income and would be a prestige factor in acknowledging the importance of trained science teachers to the nation.

Many retired officers of the Armed Forces have embarked on a second career of service to their country in volunteering as teachers in public and private schools. Retirement pay enables them to live on a teacher's salary without too much sacrifice, and in teaching they continue to serve their country. With encouragement from local school boards, state licensing authorities, and teacher training institutions, more capable teachers could be recruited from this source.

The suggestions we have made admittedly fall short of a wholesale overhaul of our educational system. It does not provide the additional support which many "poor" school districts need to supplement inadequate tax receipts. In effect, it is proposed only as a specific and prompt remedy for the shortage of scientific personnel, and does not preclude the up-grading of all school systems and curriculums by any and all available means.

The shortage of scientists and engineers, of which we have so lately become aware, will in time correct itself through the normal operation of supply and demand. However, so slow a method could let Russia take a dangerous lead in scientific and military development. Effective measures are immediately needed to channel an increasing number of the finest intellects of our young students into scientific and engineering careers. No radically new type of program is required because methods previously used to promote Vocational training, Veteran's Education, and NROTC can be adapted to this new need. Prompt action can still give education a powerful assist to win its "race with catastrophe."

Season's Greetings

At the close of our first year of publication, the editorial staff of MILITARY AUTOMATION extends the best wishes of the season to its readers and patrons.

In looking back on 1957, we believe that it will be remembered as a crucial year in our National Defense. We hope that our national complacency has been shaken to the extent that a new dedication and sense of urgency will govern legislative and administrative measures in the months and years which follow. This will result only if the voters feel this urgency and let their leaders know they are concerned. Conversely, it is up to our leaders to furnish us with realistic reports on the actual state of Defense, not soothing fables about how new cuts in Military expenditures will bring us better defense.

MILITARY AUTOMATION will continue its educational service to all the Armed Forces and to industry which supplies complex instrumentation, data processing and weapons systems for their urgent requirements. The need for every military systems technician and engineer to broaden and deepen his understanding of automatic techniques was never greater. That we are succeeding in this service is evidenced by the many letters we have received and by the high interest shown by our readers in requesting educational and informational material offered by our advertisers.

We look forward to 1958 with high expectations. It probably will be harder to make and keep a buck than in the past, but we will not be bored! Happy Christmas and a rewarding New Year!

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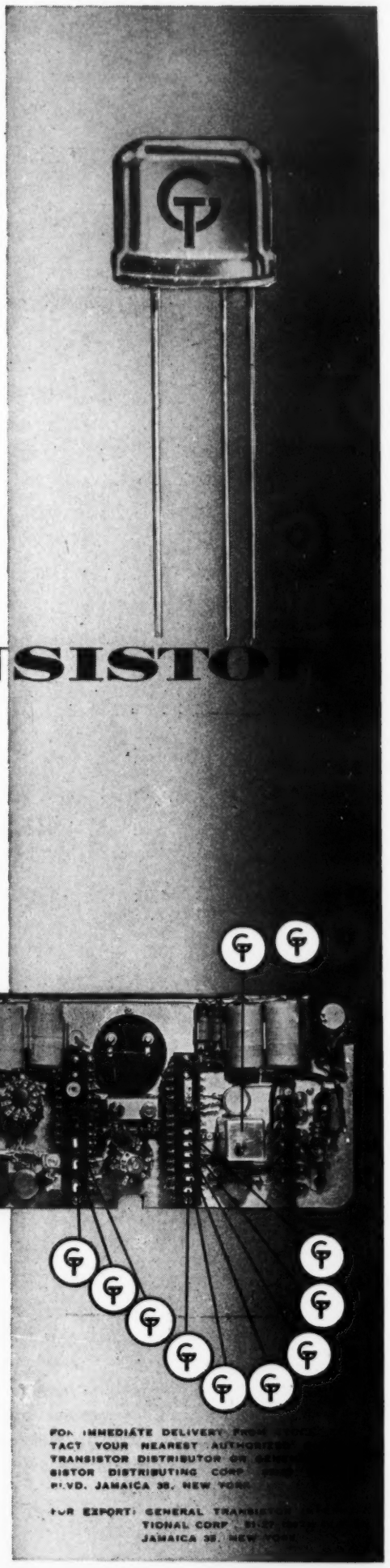

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The Klystron

THEODORE MORENO
Varian Associates, Palo Alto, Calif.

THEODORE MORENO

AB 1941, MA 1942, Stanford U. ScD 1949, electrical engineering, MIT. Dr. Moreno joined Varian Associates as a development engineer in March 1951 and is now manager, tube research and development, and a member of the Board of Directors. He is the author of "Microwave Transmission Design Data" as well as numerous technical papers and holds several patents in the field of microwaves.

THE klystron tube, described by its coinventor Dr. Russell H. Varian in the September-October issue of *MILITARY AUTOMATION*, is one of the tube types which permit the use of the microwave region of the radio spectrum. Because of inherent limitations, conventional radio tubes, triodes and tetrodes, operate at microwave frequencies only with great difficulty. On the other hand, the effect of finite transit time of electrons between electrodes, one of the most serious limitations of triodes and tetrodes, is an essential part of klystron operation.

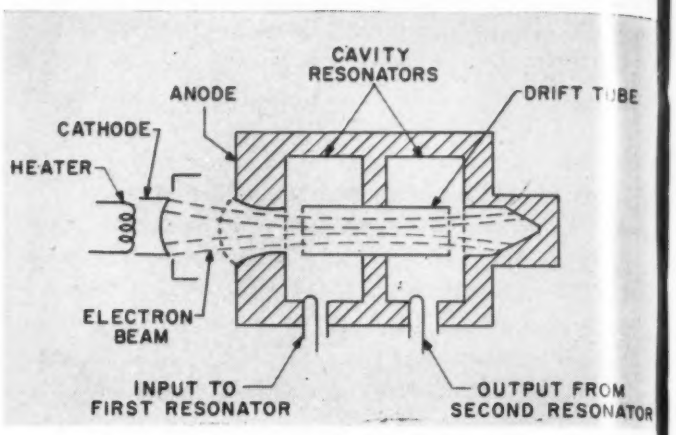
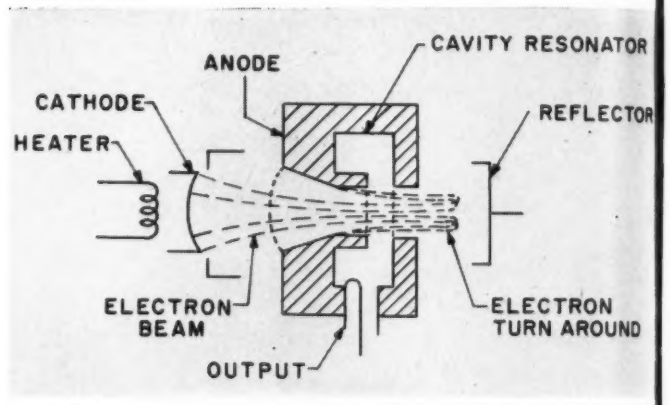


FIG. 1. SCHEMATIC DIAGRAM of two-cavity Klystron-amplifier.

FIG. 2. THE REFLECTOR ELECTRODE of a reflex klystron turns the electron stream around to pass through the cavity a second time. This is a favorite form of local oscillator for radar and other microwave applications.



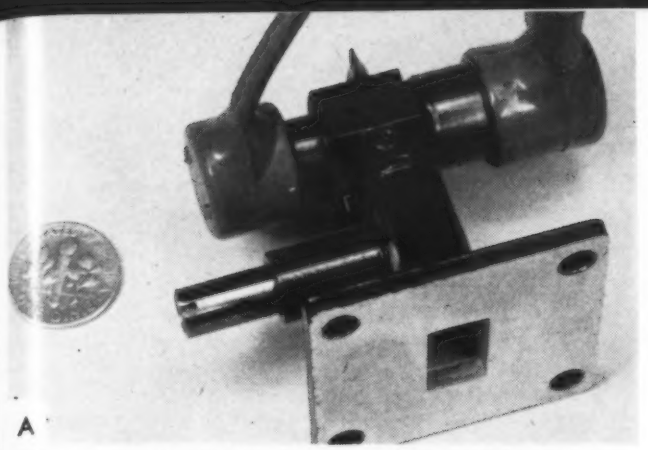
Operation

A schematic diagram of a two-cavity klystron amplifier is shown in Fig. 1. A voltage is applied between cathode and anode to draw an electron stream from the cathode. The geometry of cathode and anode is such that an electron beam is formed that passes through an aperture or grid in the anode.

The rf circuits of the klystron are formed by re-entrant cavity resonators, and the rf fields are wholly contained in the resonant cavities. The term "re-entrant" refers to the shape of the cavity wherein one side has been pushed in so that the two aperture grids are close together. The close-spaced grids of the cavity provide most of the capacitance of the resonator while the outer volume is primarily the inductance.

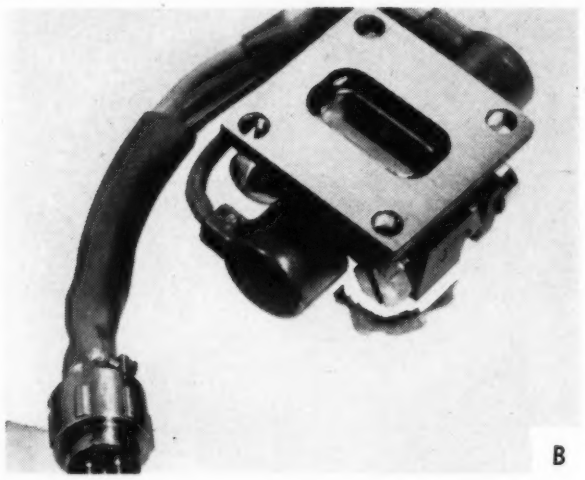
The electron beam passes through the first cavity grids, proceeds down the drift tube and passes through the second cavity grids to the collector. If a small amount of rf energy is introduced from an external source into the first cavity at its natural frequency, it will resonate and its aperture grids will be charged alternatively negative and positive. Electrons in the intergrid space will be retarded when the first grid is plus and the second grid is minus, and accelerated when the grid charges are reversed. This is "velocity modulation" in which the speeds of separate electrons are modified.

As the electron beam continues past the first resonator and on down the drift tube, the fast electrons tend to catch up with the slow electrons, and the beam forms a stream of bunches of electrons. This bunched beam is directed through the grids of the second cavity resonator, and induces an oscillating electromagnetic field in that second resonator if it is tuned to the same frequency as the first resonator. A greater amount of power can be extracted from the second resonator than was fed into the first resonator, and the klystron therefore acts as an amplifier of microwave energy. The two-cavity klystron amplifier can be converted into an oscillator by coupling some of the energy developed in the second resonator back into the first resonator. In another form of klystron oscillator, the reflex klystron, a single cavity resonator is used. (Fig. 2). The electron beam passes through the cavity once, is reflected by a reflector electrode (which is operated at a potential more negative than the cathode) and passes through the cavity a second time.



A

FIG. 3. KLYSTRONS FOR GUIDED MISSILES are small and have molded leads. A. Varian Associates type VA201B Reflex Klystron has 100 mw output at 10 kmc, with stub tuning control. B. Bomac type BL803 has 15-25 mw (minimum output) at 8.5 to 10 kmc with hexnut tuning control. Courtesy Bomac Laboratories, Inc., Beverly, Mass.



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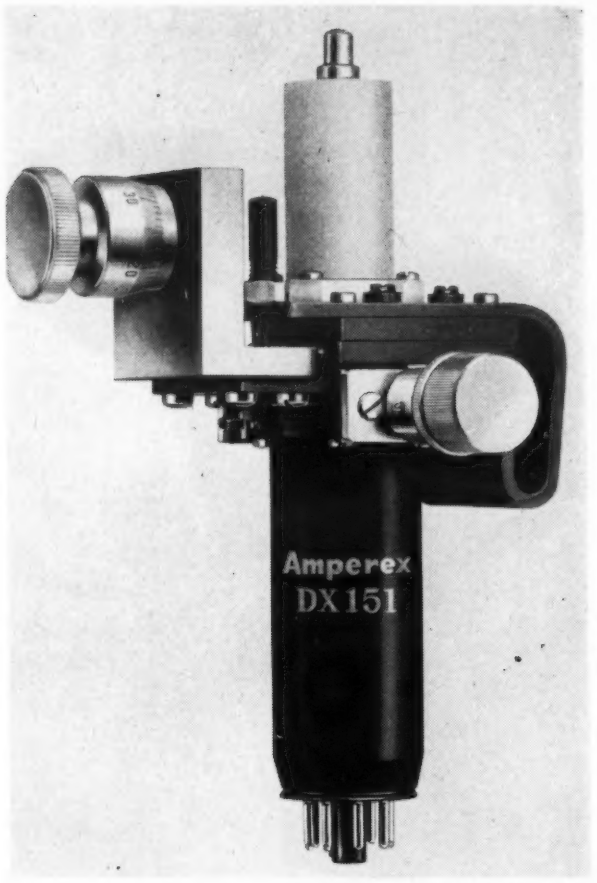


FIG. 4. EHF BAND TUNABLE REFLEX KLYSTRON has 40 milliwatts power output at center of 69.5-77kmc range. Courtesy Amperex Electronic Corporation, 230 Duffy Ave., Hicksville, N. Y.

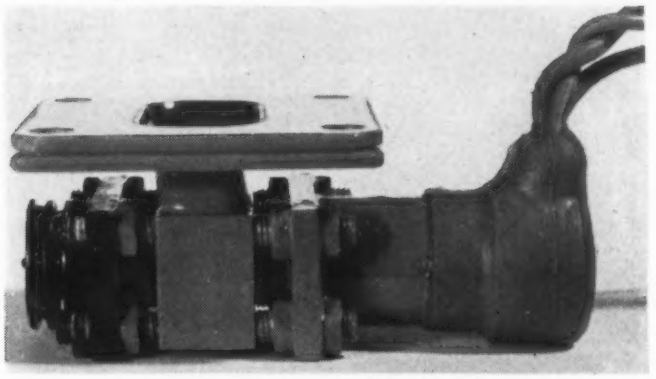
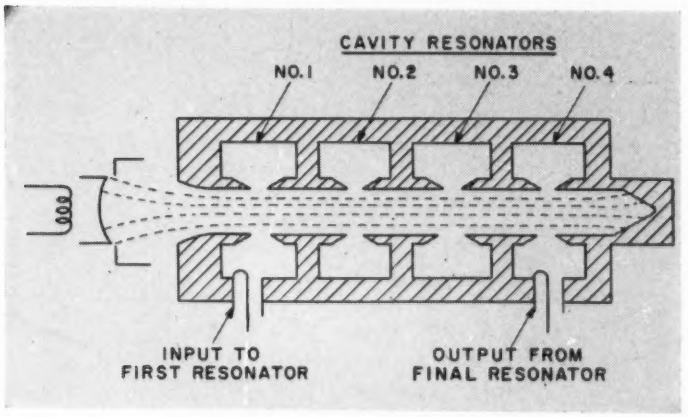


FIG. 5. TWO-CAVITY KLYSTRON OSCILLATOR, Varian Associates type V-23, is typical tube for aircraft doppler navigation applications.

FIG. 6. CASCADE KLYSTRONS OFFER HIGHER gain or broadbanding by stagger-tuning at expense of decreased gain.



Local Oscillator

After the invention of the klystron in the late nineteen-thirties many experimental klystrons were built, including some relatively high-power tubes. When the intensive development of microwave radar was undertaken as a result of World War II, the magnetron was chosen as the standard transmitter tube and the reflex klystron adopted as the local oscillator for the receiver. Work on other types of klystrons was carried on at a relatively low level for a number of years. The reflex klystron has continued to be the standard tube for the local oscillator of radar receivers, and has undergone continual evolution and improvement. Most recent improvements have been largely in the mechanical design for operation in severe environments, such as are encountered in guided missiles (Fig. 3). A typical tube of this type will produce 100 milliwatts of power at a frequency of 10,000 megacycles. Reflex klystrons have been made to operate at frequencies as low as a few hundred megacycles and above 75,000 megacycles. Fig. 4 shows a 10 milliwatt minimum power, 65.5 to 77.5 kilomegacycle klystron recently announced by Amperex.

Since World War II, reflex klystrons also have been modified to operate as transmitting tubes in low-power microwave relay systems. One such tube produces about one watt of power at frequencies in the neighborhood of 7000 megacycles. The reflex klystron is favored for this application because of its inherent low distortion and low noise level.

Cascade Amplifiers

Much recent development work has been devoted to klystron amplifiers, rather than oscillators. Nearly all klystron amplifiers are cascade amplifiers with more than two resonant cavities. (Fig. 6). The input signal is coupled into the first cavity and the output signal is coupled out of the final cavity. The intermediate cavities are coupled only to the electron beam and not to any external circuit.

Placing additional cavities along the electron beam is equivalent to building additional stages of amplification into a single tube. A four-cavity klystron will typically have a power gain of fifty to sixty db, and still higher gains can be obtained with additional cavities. Cavities also can be stagger-tuned in a manner analogous to wide-band intermediate-frequency amplifiers and the bandwidth of the klystron will be increased as the gain is reduced. High-power multicavity klystron amplifiers when stagger-tuned will have typical bandwidths in the range of one-half percent to a few percent of the center frequency.

When more than two cavities are used, it is usually necessary to immerse the klystron in a strong magnetic field parallel to the direction of electron flow. This magnetic field prevents the electron beam from spreading apart because of the mutual repulsion of the electrons, and maintains the electron beam in pencil form while it passes through the series of cavity resonators.

High-Power Amplifiers

Amplifier klystrons of increasingly high power are being developed, and the klystron is now capable of producing at least as much power as any other type of microwave tube over most of the microwave frequency spectrum. Continuous-wave klystrons of many kilowatts of average power have been developed for high-power transmitter applications. (Fig. 7). They are used extensively in high-power transmitters designed for long-range, microwave tropospheric scatter communication. Communication links of this type can

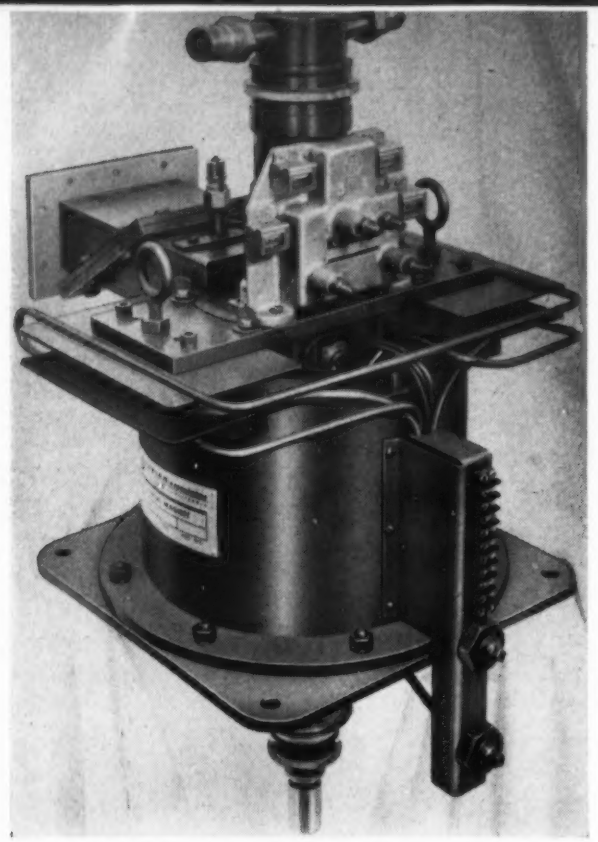


FIG. 7. VARIAN ASSOCIATES TYPE VA-800 is a high-power C-W klystron amplifier for tropospheric scatter communications.

FIG. 8. TYPE X626 PULSE KLYSTRON MEASURES 10 ft. 6 in. and is designed to generate over 1.25 megawatt peak power and 100kw average in the 400 mc range. Courtesy Eitel-McCullough, Inc., San Bruno, Calif.

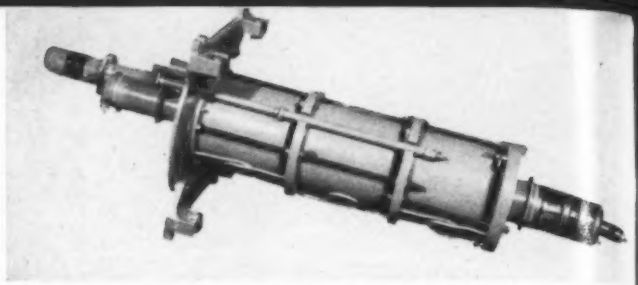


FIG. 9. THREE-CAVITY 12-KW UHF TV OUTPUT amplifier for visual carrier detunes center cavity for broadband response. Drift tubes and collectors are watercooled. Courtesy General Electric, Electronic Components Div., Schenectady, N. Y.

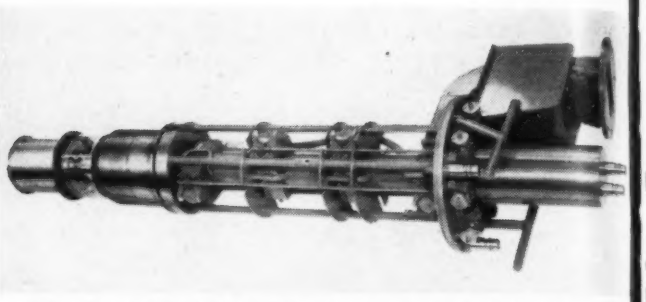


FIG. 10. HIGH-POWER PULSE KLYSTRON AMPLIFIER, Varian Associates Type VA-87, facilitates discrimination between stationary and moving targets.

be operated reliably over distances of several hundred miles. Other applications include UHF television broadcasting (Fig. 9) and missile guidance radars.

The fact that power klystrons are stable, high-gain amplifiers instead of self-excited oscillators makes it possible to design much more sophisticated and higher-performance systems than would otherwise be possible. The inherently low noise level and linear amplification properties are very important to system designers.

Pulse Klystrons

Many types of high-power pulse klystrons also have been developed. Perhaps the most spectacular is the very-high-power tube that was developed by Stanford University to supply radio-frequency energy to a linear accelerator constructed there. These klystrons have developed peak powers of thirty megawatts at a frequency of about 2850 megacycles, more power than has been produced by any other type of radio tube at any frequency. Twenty-two of these klystrons supplying energy to the 220-foot linear accelerator have speeded up electrons to energies approaching one billion volts. Another high-power pulse klystron developed by Eitel-McCullough for radar and linear accelerator operation (Fig. 8) generates over 1250 kw peak power output.

Other high-power pulse klystrons amplifiers have been developed for radar transmitters. Because they are amplifiers, they make possible the design of very elegant systems capable of a high degree of discrimination between moving targets and fixed targets. (Fig. 10).

Doppler Radar

Klystron tubes are finding increasing use in the receiving and transmitting circuits of airborne Doppler navigation systems. Fig. 11 shows a functional diagram of the AN/APN-81 system, developed by the General Precision Laboratory, Pleasantville, N. Y. This equipment detects the difference in doppler shift between signals from right and left antennas to orient the antenna mount to the true ground course. Plane drift, wind speed, and air speed is then computed by the equipment. A 2K25 Raytheon klystron is used in the military version and a Varian Type (Fig. 5) in RADAN, the commercial model of this equipment. (Unless otherwise acknowledged, all illustrations in this article are by courtesy Varian Associates, Palo Alto, Calif.)

Since its invention the klystron has established itself as an important part of many types of microwave systems. Although newer microwave types, such as travelling-wave and backward-wave tubes, will undoubtedly be used increasingly in the future the klystron should continue to play an important role for many years to come.

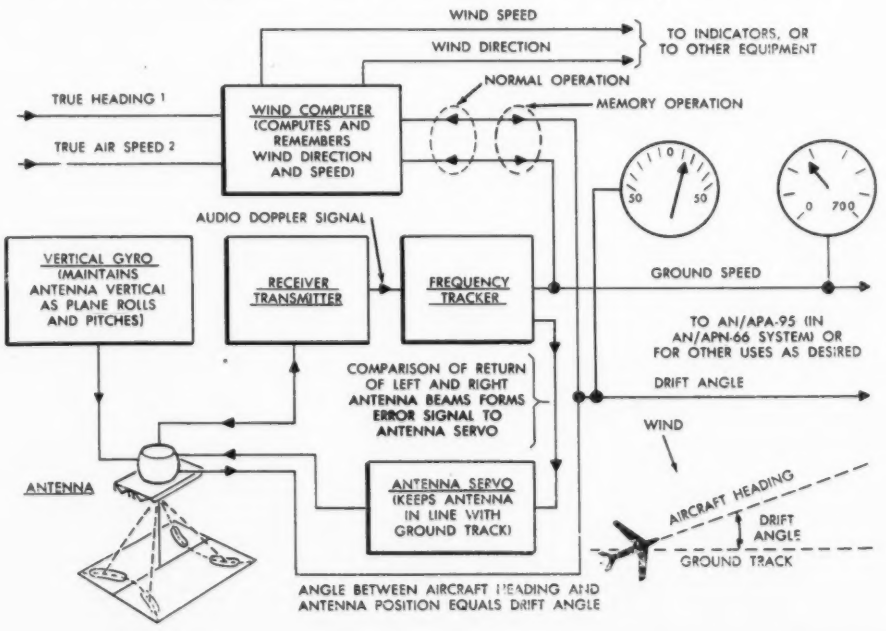

WIND SPEED
WIND DIRECTION
TO INDICATORS, OR TO OTHER EQUIPMENT
NORMAL OPERATION
MEMORY OPERATION
TRUE HEADING 1
TRUE AIR SPEED 2
WIND COMPUTER (COMPUTES AND REMEMBERS WIND DIRECTION AND SPEED)
AUDIO DOPPLER SIGNAL
VERTICAL GYRO (MAINTAINS ANTENNA VERTICAL AS PLANE ROLLS AND PITCHES)
RECEIVER TRANSMITTER
FREQUENCY TRACKER
GROUND SPEED
TO AN/APA-95 (IN AN/APN-66 SYSTEM) OR FOR OTHER USES AS DESIRED
DRIFT ANGLE
COMPARISON OF RETURN OF LEFT AND RIGHT ANTENNA BEAMS FORMS ERROR SIGNAL TO ANTENNA SERVO
WIND
ANTENNA
ANTENNA SERVO (KEEPS ANTENNA IN LINE WITH GROUND TRACK)
AIRCRAFT HEADING
DRIFT ANGLE
GROUND TRACK
ANGLE BETWEEN AIRCRAFT HEADING AND ANTENNA POSITION EQUALS DRIFT ANGLE

FIG. 11. AN/APN-81 DOPPLER NAVIGATIONAL radar system. A low-power reflex klystron oscillator is used in the antenna-receiver tracker to shift incoming rf down to a frequency which is more easily amplified. Courtesy General Precision Laboratory, Pleasantville, N. Y.

AUTOMATIC FLARE LANDING SYSTEM

DOWNEY, CALIF.—Successful automatic landings in subsonic and supersonic aircraft have been accomplished by a new flare landing system (Fig. 1)

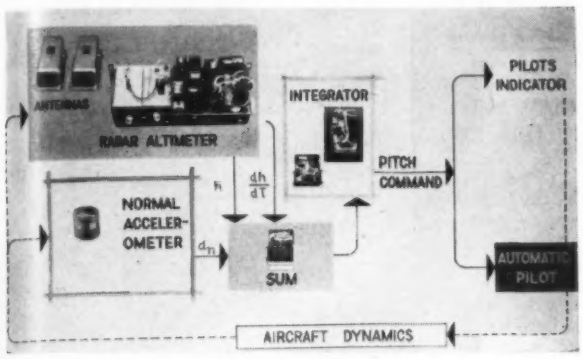


Fig. 1. Functional Diagram, AFLS.

developed by Autonetics Div., North American Aviation Inc., 9150 E. Imperial Hwy., Bellflower, Calif., under the supervision of the U. S. Air Force. The system operates by automatically flaring an aircraft through a predetermined path to touchdown (Fig. 2).

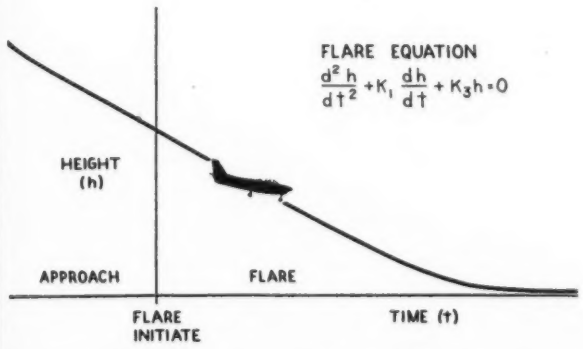


Fig. 2. Flare path is computed by airborne system.

The system provides fly-up or fly-down signals that are coupled to the autopilot, and flare can be triggered by the system at any altitude up to 500′. "Hands off" landings have been successfully handled in both jet aircraft and unmanned missiles. Used in conjunction with ILS or GCA it provides all-weather landing capabilities and is adaptable to hovering-type aircraft.

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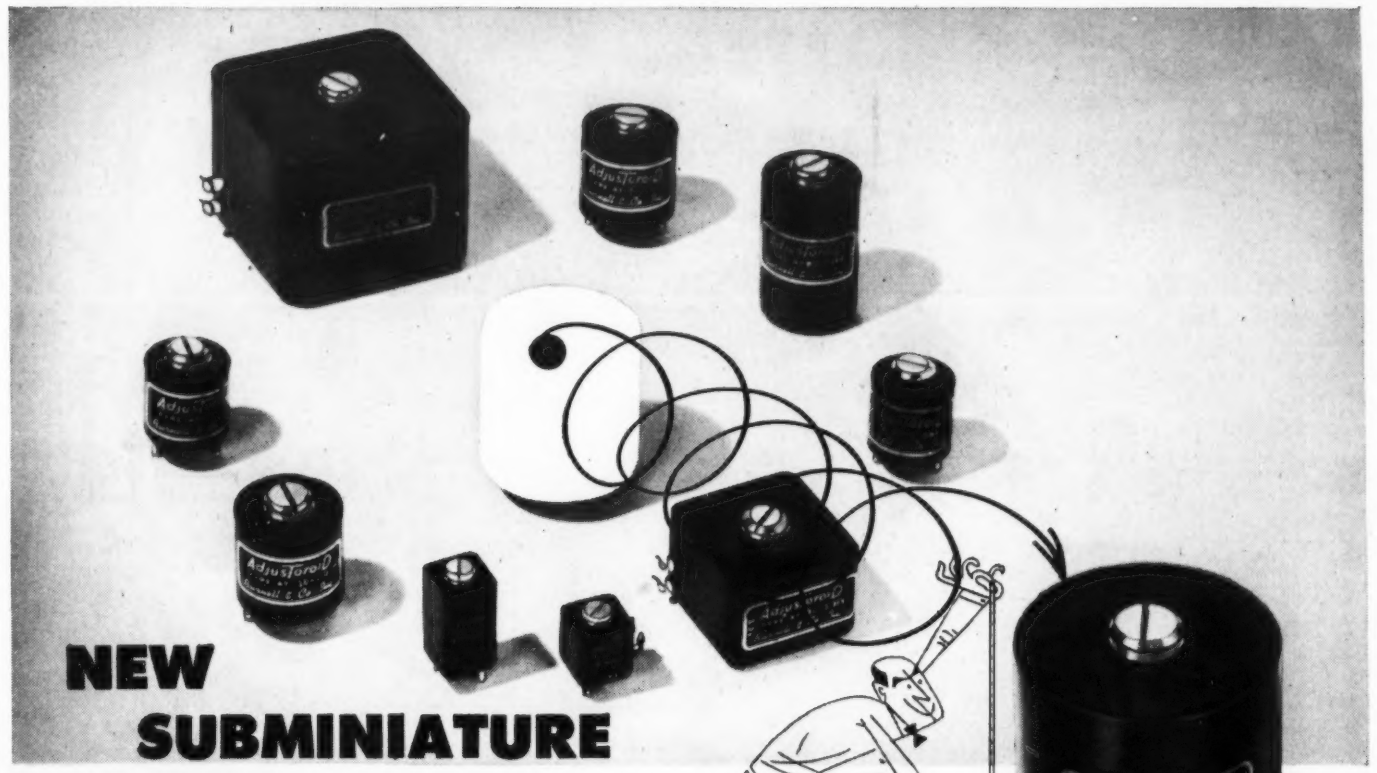

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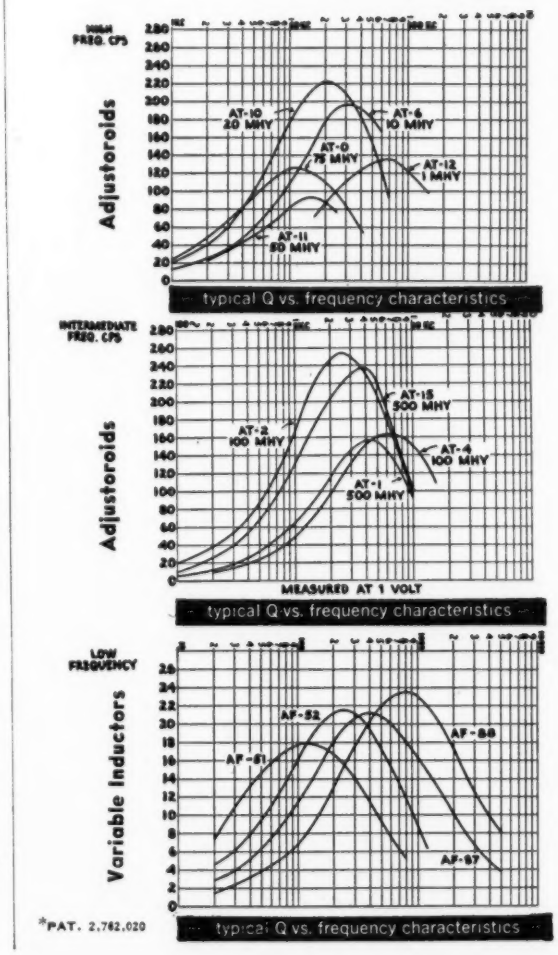

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AT-1	1 3/4	1 3/4	1 1/4″	7 1/4 oz	2 kç to 10 kc	4 kc	15 hys
AT-2	2 3/4	2 3/4	2 1/4″	24 oz	Below 2.5 kc	2.5 kc	125 hys
AT-4	1 11/64		1 1/4″	4 oz	1 kc to 16 kc	6 kc	15 hys
AT-6	1 1/16		1″	2 oz	10 kc to 100 kc	30 kc	.75 hys
AT-10	1 11/64		1 1/4″	4 oz	3 kc to 50 kc	20 kc	.75 hys
AT-11	45/64	45/64	3/4″	.83 oz	2 kc to 25 kc	15 kc	5 hys
AT-12	45/64	45/64	3/4″	.83 oz	15 kc to 150 kc	60 kc	.5 hys
AT-15	1 31/32		1 7/8″	14 oz	Below 5 kc	4 kc	125 hys
AF-51	1 11/64		2″	5 oz	30 cps to 500 cps	120 cps	1000 hys
AF-52	1 11/64		2″	5 oz	50 cps to 1 kc	250 cps	1000 hys
AF-87	45/64	45/64	1 1/4″	1.7 oz	90 cps to 2 kc	400 cps	80 hys
AF-88	45/64	45/64	1 1/4″	1.7 oz	1.6 kc to 4 kc	800 cps	42 hys

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RYAN 1-2841
TELETYPE: PASACAL 7578
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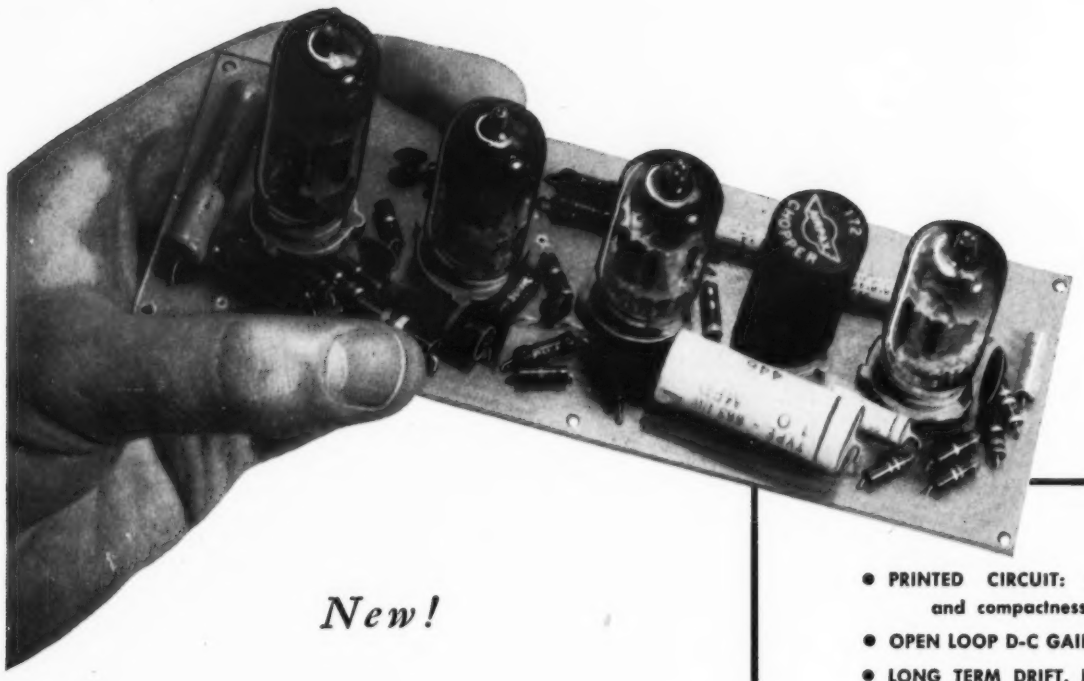
For more information circle **8** on inquiry card.



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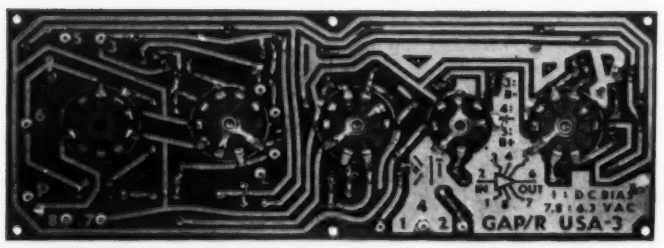
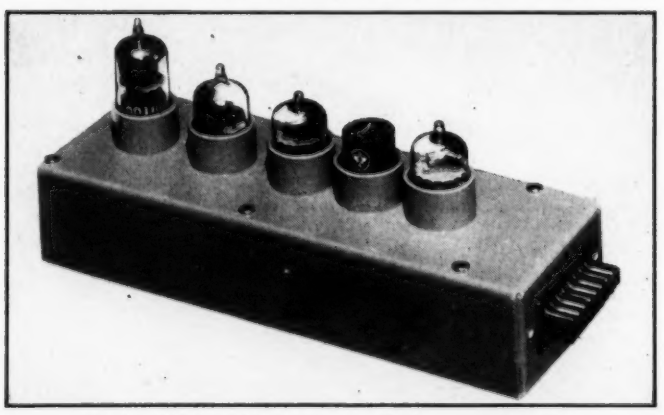


Underside of Model USA-3 showing printed circuit, amplifier connection scheme, and connecting terminals.



Model USA-3 showing one of the several types of modular packaging available at extra cost.

Model USA-3

High performance combined with the reliability and compactness of a printed circuit design are featured in the new Philbrick Universal Stabilized Amplifier, Model USA-3. It is ideally suited for applications to instrumentation, control and analog computation. Extremely high open-loop d-c gain, wide bandwidth, low noise and wide output range are important performance characteristics of this new chopper stabilized amplifier. An interesting design feature makes this instrument safe against self-destruction, even under prolonged overload conditions or direct grounding of its output. At a price of only $95.00, it offers more performance per dollar than any other amplifier on the market today. *Write to George A. Philbrick Researches, Inc., Dept. 20, for Bulletin USA-3.*

GEORGE A.
PHILBRICK
RESEARCHES, INC.
230 Congress Street, Boston 10, Massachusetts

For more information circle 9 on inquiry card.

PRE-SCREENED DIAZO PIX

A method for illustrating reports on testing of missile and aircraft components and systems, making possible a halftone of lithographic quality from a diazo reproducer, has been developed by the Wyle Laboratories in cooperation with Eastman Kodak Co. (Rochester 4, N. Y.)

Fig. 1. Autoscreen Negative with halftone dot pattern is contact printed onto Diazo positive.

Fig. 2. Ozalid machine produces halftone positive print of high quality on test reports.

Photographs on Kodalith Autoscreen Ortho Film are used as the basis for this process. All photographs are made with an 8″ x 10″ camera, which produces a negative convenient for reproduction on to a standard letter sized sheet of paper. The Autoscreen film is available in 8″ x 10″ and 11″ x 14″ sheet film sizes. The photographer's original negative has a halftone dot pattern in it when it is developed and the Autoscreen negative is contact printed (Fig. 1) onto a sheet of Kodalith Ortho Matte Film Type

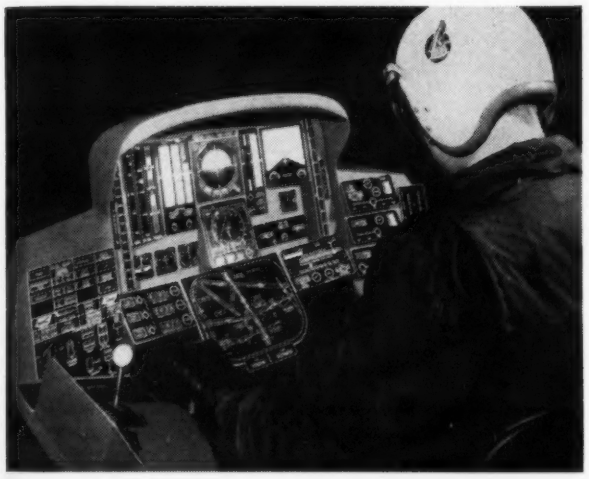
2. For this exposure, the photographer's negative is fitted into a mask thus producing a translucent positive ideal for diazo reproduction.

Titles or photographic captions to be included are typewritten directly on the film positive, thus showing up as positive on the finished copy. When the positive is put through the Ozalid machine (Fig. 2) a halftone positive print comparable to offset or letterpress printing, is produced. In the case of Wylie Laboratories, this technique has been particularly important because the reports are the firm's end product.

For more informaiton on Pre-Screened Film
circle **203** on inquiry card.

PILOT-CENTERED COCKPIT

The pilot of a supersonic jet plane is laced into a G suit, wearing helmet and oxygen mask, and is strapped to his seat with safety belt and shoulder straps. At speeds over 3 miles a second he must monitor his instruments instantly and accurately and make decisions to correct conditions. Most cockpit controls



and instruments have been developed independently, and supplied by separate manufacturers. The zero-point on the dials may appear at any point on the instrument while needles can move in the same direction, some revealing an undesirable condition others revealing a desirable one.

To simplify instrument panels, readability studies are now being made towards a "Whole Panel" development designed to plan instruments as part of the cockpit so that the information and controls which are most needed will be most readily available and readable to the pilot. Lear Inc., of Grand Rapids, Mich., in conjunction with WADC, is developing a broad cockpit improvement program and the results will be made available to all USAF contractors for application to specific airframes.

For more information on Lear Cockpit Research
circle **204** on inquiry card.

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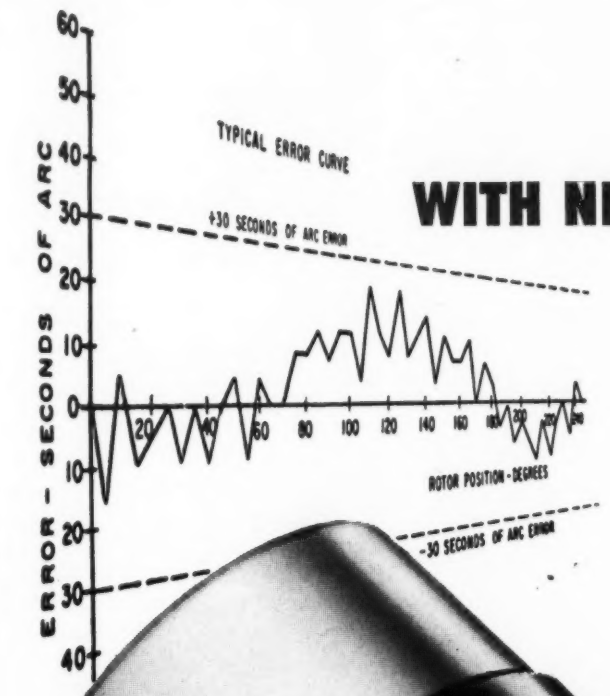

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SIZE 11 SYNCHROS for 4 wire systems offer accuracy of 3.0 minutes of arc. Standard 3 wire Synchros available with 5, 7 and 10 minute maximum errors.

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MAXIMUM ERROR
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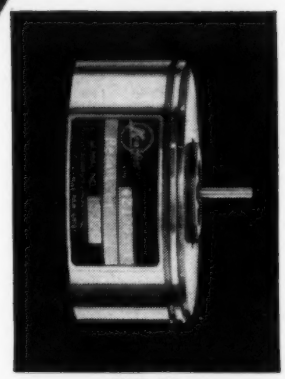

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For more information circle **10** on inquiry card.

PRINTED CIRCUITRY VI

Low unit cost of mass-produced printed-circuit packages, aided by advances in reliability and miniaturization, is changing the meaning of "component" from capacitor, resistor and tube to integrator, inverter, flip-flop, and IF stage.

Circuitry

ALLAN LYTEL, General Electric Company

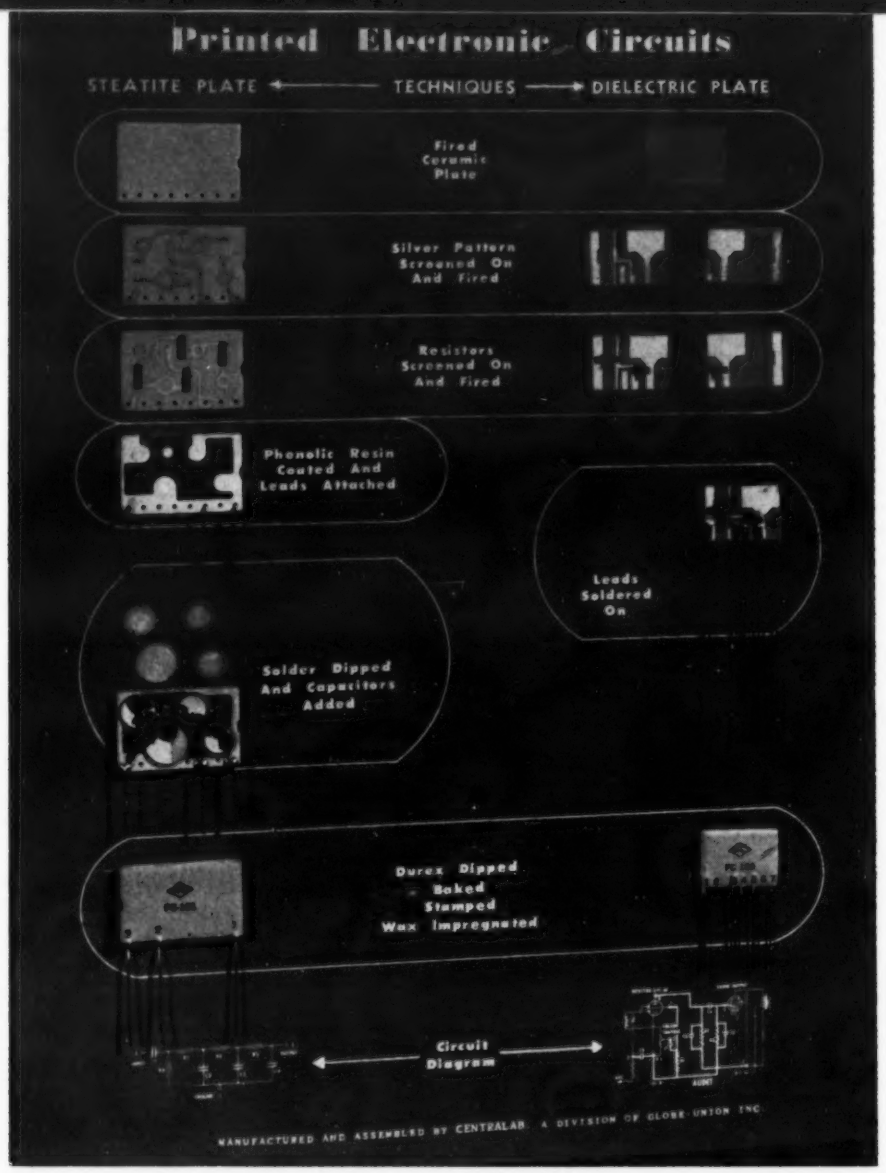


Fig. 6-1. P. E. C. (Printed Electronic Circuits) coupling packages (Photo courtesy Centralab).

PRINTED-CIRCUIT packages now encompass not only single stages but also packaged coupling sections between either conventional or printed stages. We will discuss these packaged couplers first, then expand the boundaries of our "package" to look at various discrete stages, novel package structures and applications in complete sets.

Small printed-circuit packages have been used in equipment with conventional wiring for some time. These small packages usually contain several printed components required for coupling parts of the larger circuit. Fig. 6-1 illustrates the way that these coupling circuits are made. There are two processes. In the first, a ceramic plate (Steatite is used here) receives a silver compound on its surface by a silkscreen process after which the plate is baked to produce lines of silver. The thickness of these lines, which are the conductors, is about 0.002". This is thick enough for all but very high currents because this deposited silver is almost as good a conductor as pure metallic silver.

The next step is to screen the resistive material onto the ceramic surface after which the plate is again baked to fix the resistors. The resistors are then tested for "opens" and for the proper measured value. This is important because the finished circuit will have several components and the entire unit has to be replaced if a single element becomes defective.

After testing, the resistors are coated with a phenolic resin which protects and separates them from additional elements. Separate capacitors—each an individual ceramic capacitor—are placed on top of the protective coating as shown. The capacitors join the elements underneath through openings in the coating. After the leads are connected, a coating of wax is applied and the entire unit receives an envelope of a phenolic material for protection against external physical damage. Where space must be kept to an absolute minimum—in hearing aids for example—the final external coating is sometimes omitted, but such units require more careful handling.

In the second method of production, a different base material, barium-titanate, allows the capacitors to be built as a part of the plate. Again a silver compound is screened on the base plate and fired to reduce the compound to metallic silver. But large areas on both sides of the base are made of silver; the base acts as the dielectric for the capacitor thus formed. The silver deposits that function as capacitor plates also act as conductors. Resistors can be connected by overlapping the capacitor plates; this is a good method of reducing lead inductance as there are no leads between components. After firing, the leads are attached, and the coating is applied.

Both methods are being used to produce RC circuit packages with resistance values from 50 ohms to 50 megohms at 0.5 watt rating; capacitors range from 5 $\mu\mu$f to 0.05 μf with a working voltage of 400 v dc.

Some additional coupling circuits made by these techniques are indicated in Fig. 6-2. RCA uses 10 elements in the network (shown at A) designed for a multivibrator; Strobo Research uses four resistors (shown at B) in a matched network for their Strobe-Flash; Motorola has a section (shown at C) which connects between the audio-amplifier and AVC tube and the audio output tube in a portable radio. This was designed to be used with a printed board. Fig. 6-2 D illustrates a typical package of printed components in an encapsulated case.

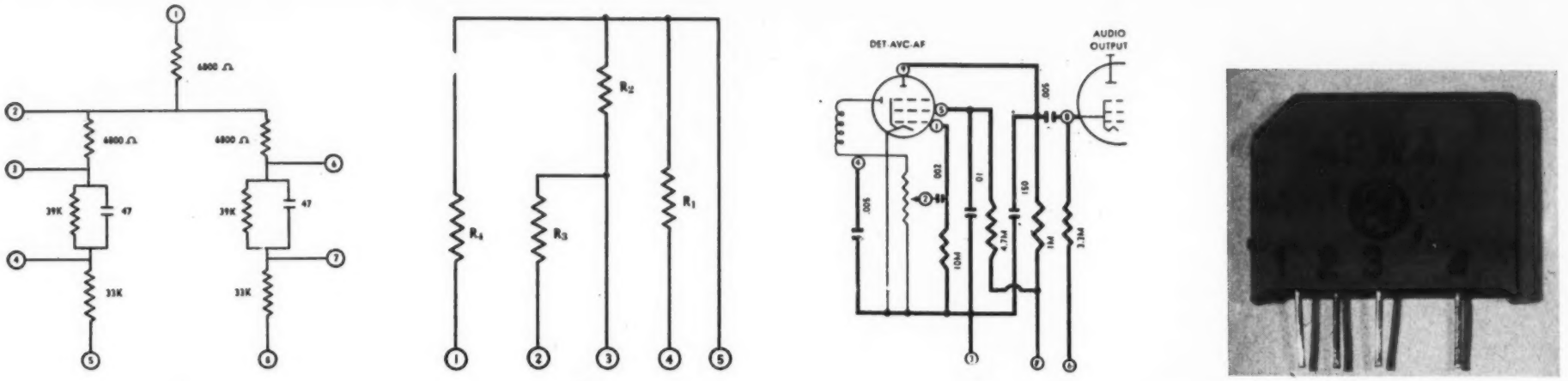


Fig. 6-2. Examples of printed-circuit packaged couplers. (Drawing A courtesy RCA; drawing C courtesy Motorola, Inc.; Photo D courtesy SECD, General Electric.)

All of these are typical special applications for the printed-circuit coupling package. There are eight generalized communications applications for these compact units. These are:

(1) *Plate circuit*—coupling from the plate of one tube to the input of the following tube.

(2) *Diode load filter*—coupling the last IF stage and diode to the AVC.

(3) *Triode coupler*—coupling triode audio stage to the audio power amplifier.

(4) *Pentode coupler*—coupling the plate and screen of the pentode detector to the output stage.

(5) *Vertical integrator*—coupling the last sync stage to the vertical oscillator. This removes the horizontal sync pulses from the composite sync signal.

(6) *TV IF filter*—for bypass or coupling in the cathode circuit on an I-F stage in a television receiver.

(7) *Audio detector coupler*—coupling the triode-detector to the final audio amplifier.

(8) *Pentode detector coupler*—coupling the pentode detector to the final audio amplifier stage.

It is possible to produce results with printed-circuit techniques which are quite different from that with conventional circuitry. For example, Figs. 6-3 and 6-4 show ladder type of integrators. These, in effect, have an infinite number of resistors and capacitors; in the printed circuit there is a single capacitor and, on the other side of the board, a single resistor. The net effect of the distributed capacity is that of a large number of both resistive and capacitive elements which makes for smooth filtering.

Plug-In Assemblies

Standardized components can be combined in plug-in modular packages such as shown in Fig. 6-5. This unit, known as PAC (Pin Assembly Circuit), uses a phenolic base which is copper clad for its internal printed wiring. Fig. 6-6 identifies the standardized, cylindrical elements with their circuit function and also reveals the board wiring. After the components are placed in their clips, the board is dip-soldered. A plastic jacket over the entire assembly completes the job.

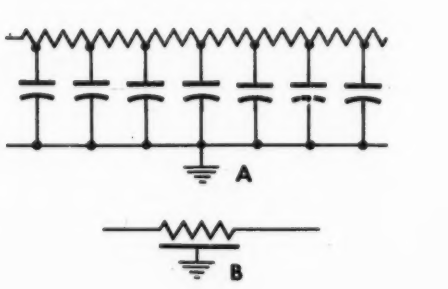


Fig. 6-3. A is Ladder type integrator employing an infinite number of capaciters and resistors. B is simplified schematic of the circuit of A. (Drawing courtesy Centralab)

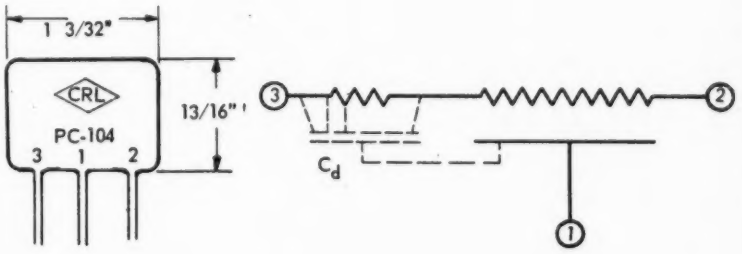
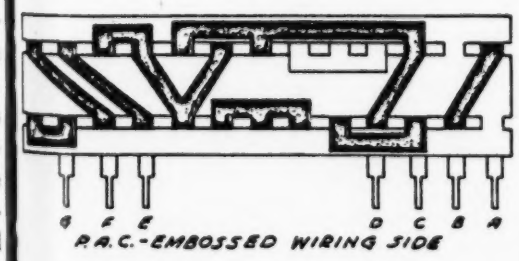


Fig. 6-4. Low-input-capacity integrator, PC-104. Components: R—38.4 K ±20%; C—12000 μμf +50—20%; C_d—8 μμf max. (Drawing courtesy Centralab)

Fig. 6-5. Assembler mounts standardized components on printed board. (Photo courtesy Erie Resistor)



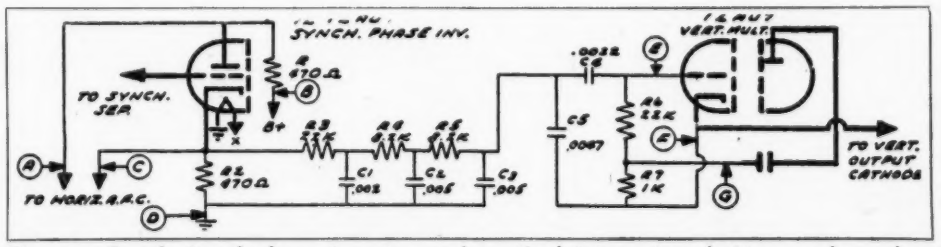
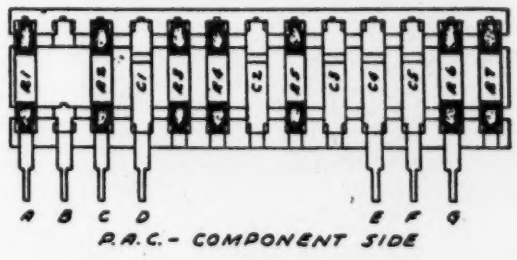


Fig. 6-6 Synch-signal phase inverter and vertical integrator. Letters and numbers relate components and terminals to schematic circuit diagram. (Drawing courtesy Erie Resistor)



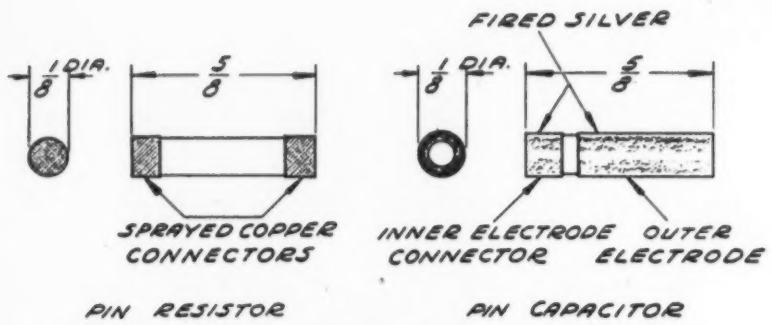


Fig. 6-7. Packaged assembly circuit components. (Drawing courtesy Erie Resistor)

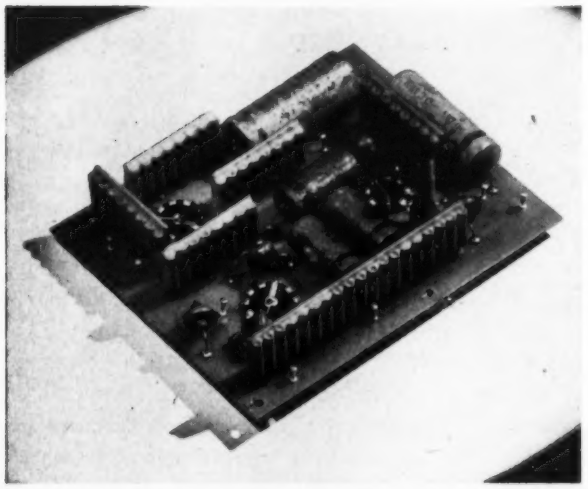


Fig. 6-8. PAC components groups mounted on larger circuit board, that is also a printed circuit. (Photo courtesy Erie Resistor)

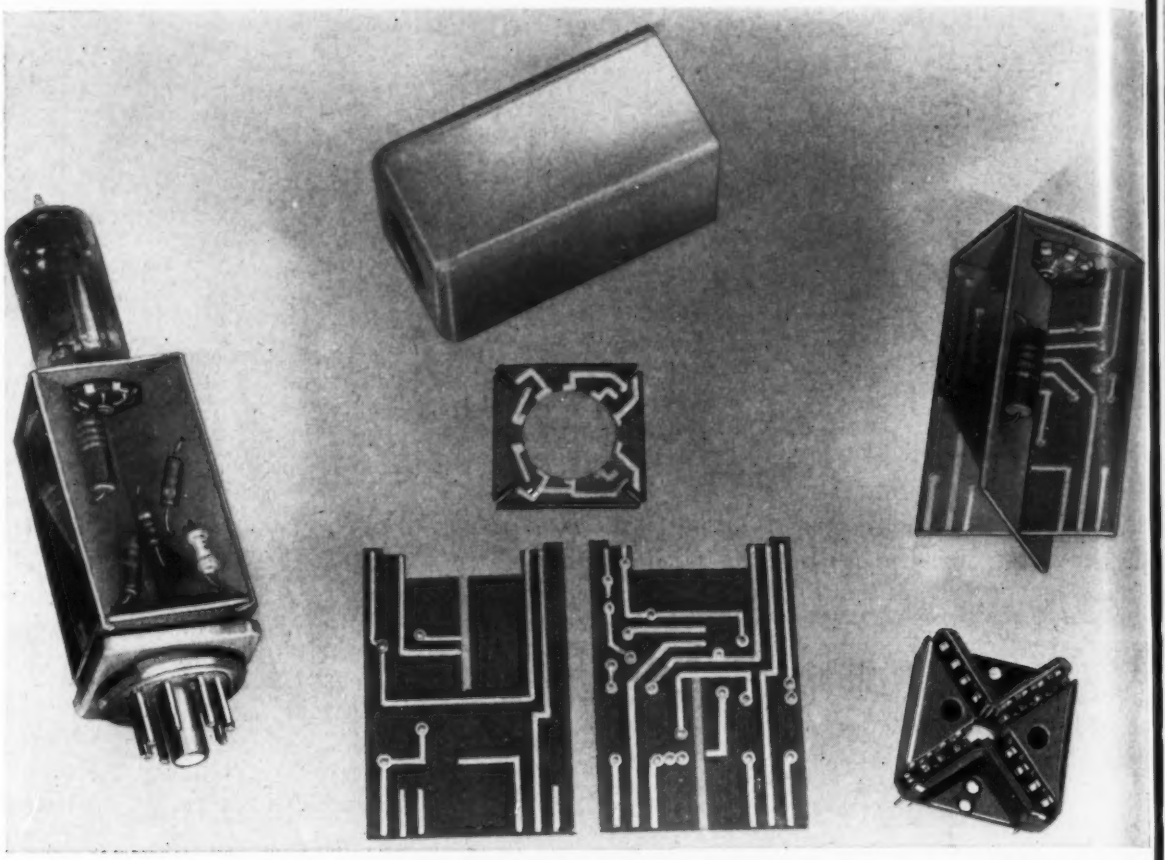
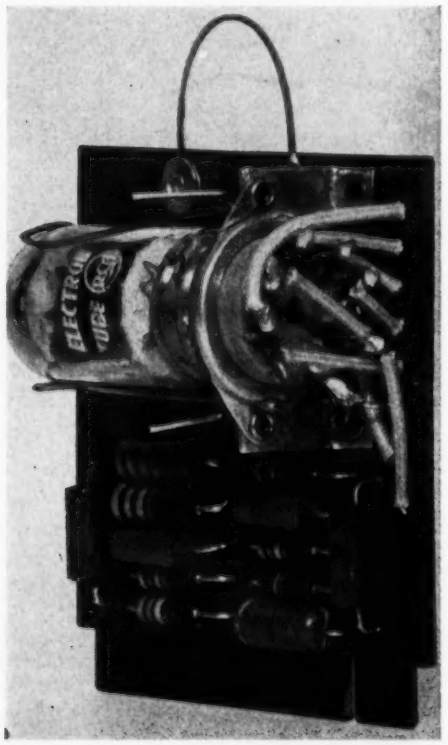


Fig. 6-9. Stages in assembly of PLUS module. Flat boards at bottom center are joined as shown at upper right. Completed module is shown at left without shield (shown at top) to reveal mounting of components. Special base shown at lower right can be used in lieu of standard octal base for mounting plug-in. (Photo courtesy Arthur Ansley Mfg. Co.)



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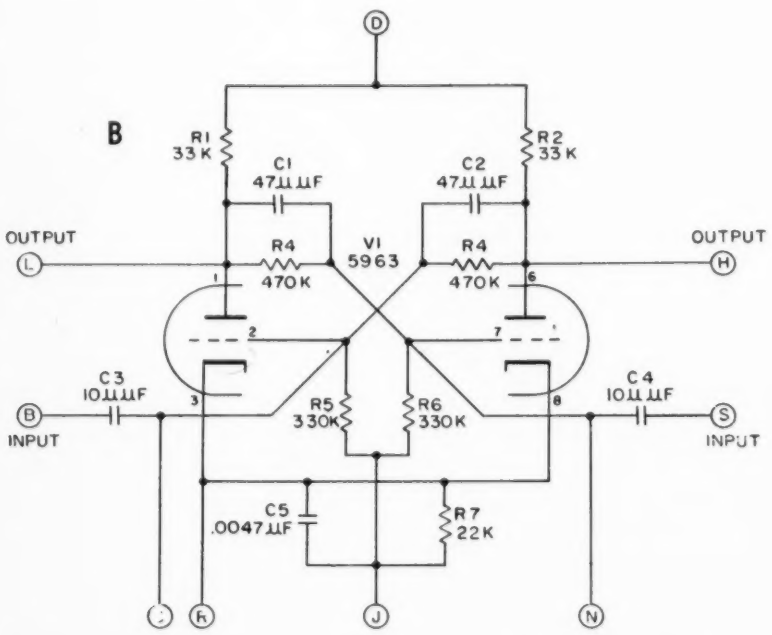
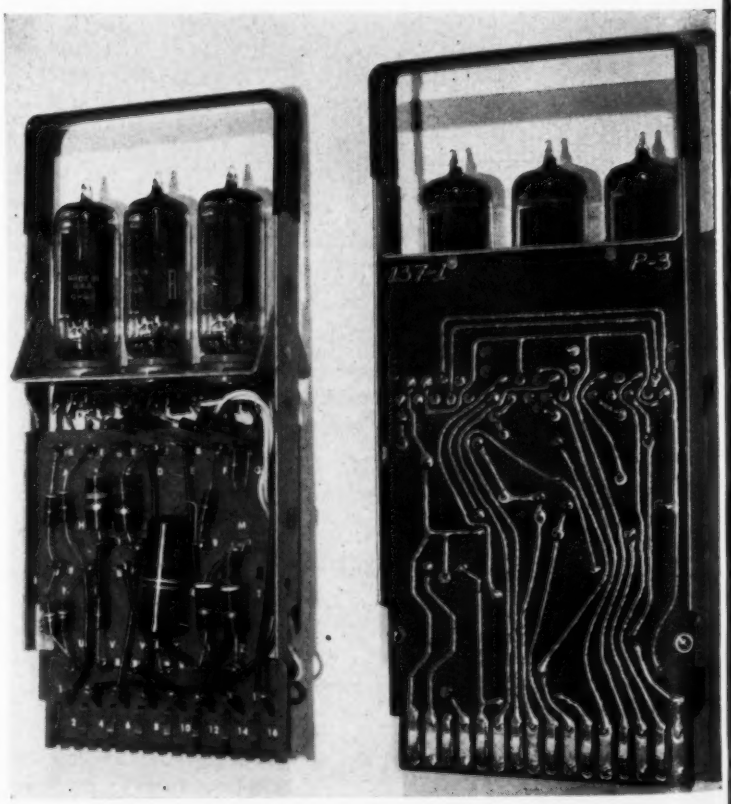


Fig. 6-10. A shows a printed circuit plug in flip-flop and B shows its schematic. C shows plug-in with another method of mounting tubes. (A and B courtesy EEco Production Co.; C courtesy RCA)



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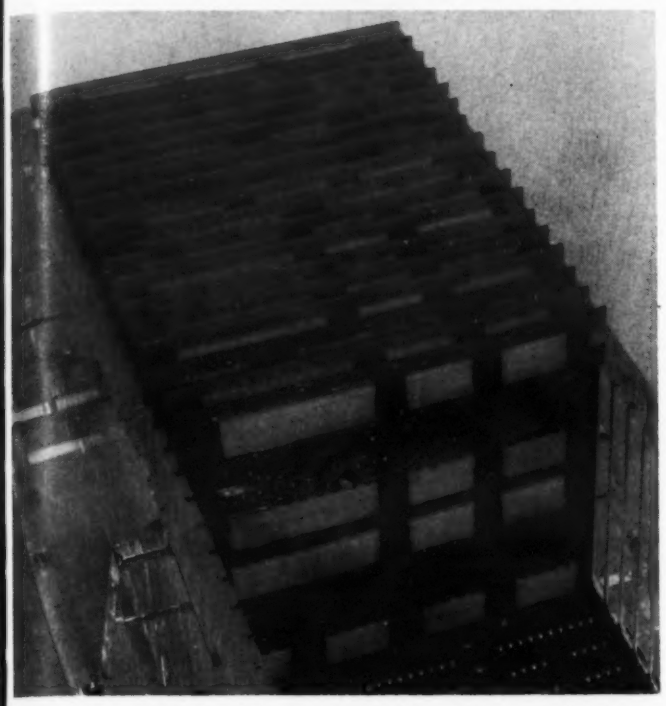

Fig. 6-11. Boards with encapsulated, direct-coupled transistors are interconnected as shown for use in a digital computer. (Photo courtesy Philco.)

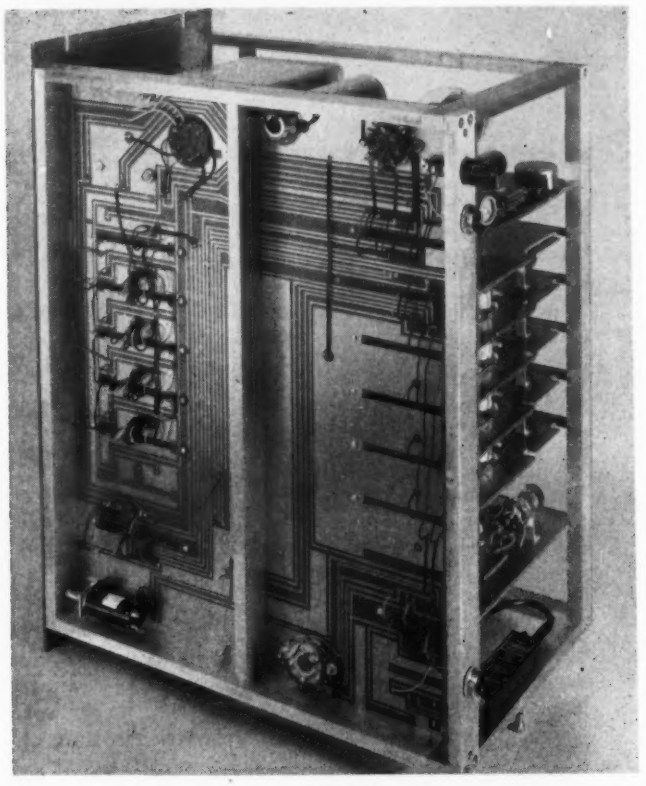

Fig. 6-12. Bottom view of digital voltmeter. (Photo courtesy Linear Systems, Inc.)

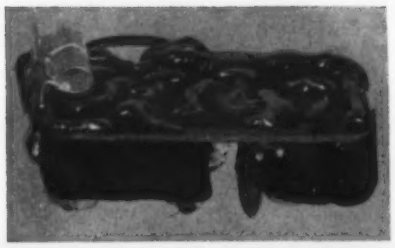

Fig. 6-13. Hearing aid using a printed circuit. (Photo courtesy Maico, Inc.)

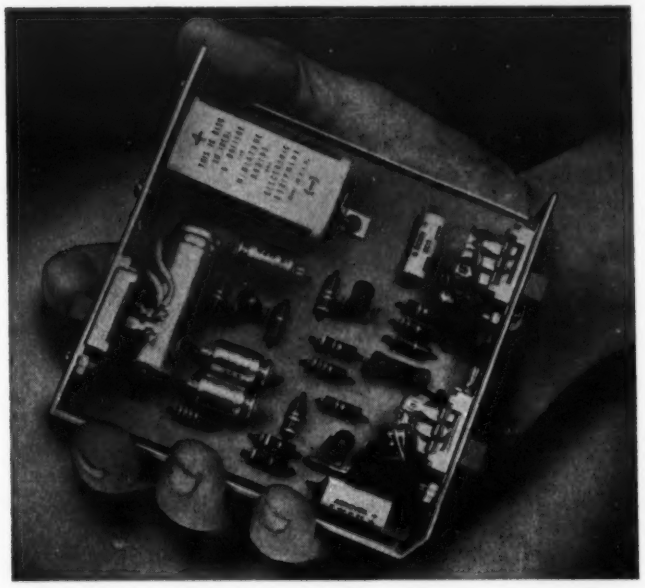

Fig. 6-14. Transistor pre-amplifier. (Photo courtesy Fisher Radio Corp.)

Components with a uniform 1/8" dia and 5/8" length are both resistors and ceramic tubular capacitors (Fig. 6-7). Resistors are rated at 1/2 watt and 350 volts with values from 5 ohms to 50 megohms. (Circuit wiring allows the resistors to be connected in series or parallel so that the circuit ratings can be greater.) Capacities up to 5100 $\mu\mu$f can be obtained from single components.

Because the PAC boards are mounted vertically on the printed-circuit board they save space (Fig. 6-8); only one square inch is needed for 15 components.

These small-package printed circuits provide for easier maintenance, and also permit the use of one large printed board for several different circuits by rearranging the plug-in elements.

Structures

The idea of the PLUS* module, shown complete at left of Fig. 6-9, is basically the forming of structural columns from the printed-circuit boards (shown at the bottom). These boards can be made with circuits on one or both sides and the components can be assembled and the boards dip soldered either manually or by standard automatic equipment while they are still flat. They are then assembled together by means of interlocking slots and crossovers that connect one board to the other. A tube socket can be attached to one end of the column; if transistors or sub-miniature tubes are mounted on the interlocking boards themselves, this top plate can be used for additional circuitry. Various types of plugs can be used on the bottom, including the standard octal plug or a special plug known as the PLUS base which makes contact with the circuit lines on the lower edges of the boards and provides up to 32 contacts. This PLUS base also is provided with ventilating holes in each of the 4 segments of the column, to provide for either a forced or convection circulation of air over the components and out around the tube socket at the top.

Printed circuits have important applications in large-scale digital computers, automatic control devices and pulse-coded communications. Many circuits of the same type are used repeatedly; these include flip-flops, counters, gates, etc. and printed-circuit techniques make possible plug-in units such as shown in Fig. 6-10. Rather than holding several large chassis, racks now have clusters of plug-in sockets for small boards. Printed wiring is used not only on the small boards but also between boards as rack wiring. Note that the wiring in Fig. 6-10, B is printed but the components are attached to lugs that meet the printed conductors. This modified construction is used in hand assembly of printed boards for a short production run. Tubes, in this case, are mounted on a shelf so that the finished board is not wider than necessary; this allows mounting of adjacent boards quite close together to save space.

An experimental packaging technique for Philco's printed-circuit, transistorized, Transac computer is shown in Fig. 6. These plug-in cards permit rapid access to any circuit for maintenance. Because the circuits are physically and electrically grouped, troubleshooting is rapid and faults can be found by operating the computer to isolate defective cards.

Fig. 6. shows a laboratory digital voltmeter which indicates, by displayed numbers, the value of the voltage under test. Seven small boards fit into connectors mounted on the large bottom board shown. Components which normally are not mounted on boards, such as large filter capacitors, power transformers, and high-voltage tube sockets, have been used successfully in this package.

Audio Amplifiers

Printed circuits are used in audio amplifiers from the smallest hearings aids (Fig. 6) to large broadcast studio amplifiers.

Fig. 6-14 illustrates an all transistor pre-amplifier. Hum levels are important in preamplifiers and this unit uses battery operation of the transistors to eliminate the hum problem. Three 2N109 transistors use only 0.0217 watts; frequency response is flat within 0.5 db from 20 to 20,000 cycles.

Following chapters include:

Production including Automation (*in next issue*)
Servicing

*Trademark Arthur Ansley Mfg. Co.

Transverse-swept magnetic tape provides a new dimension for recording images and "other" wide-band phenomena.

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Ampex Corporation

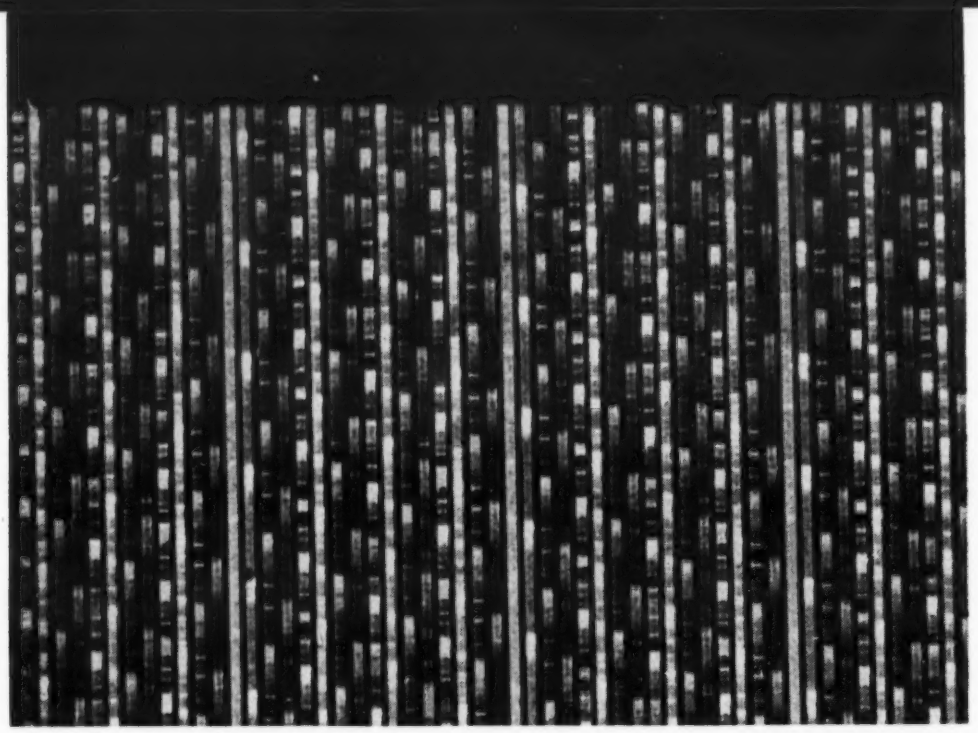


FIG. 1. PHOTOMICROGRAPH OF A SECTION of recorded videotape which has been "developed" with a solution of carbonyl iron particles to produce a visual image of the recorded magnetic impulses on the tape. The upper 7/10th of an inch is shown, magnified 11½ times. The wide stripe along the upper edge is the audio track, after passing the erase head.

VIDEOTAPE MAGNETIC RECORDING

THE IDEA of recording television pictures on magnetic tape occurred to many engineers during the last decade. Television pictures are an electrical display of information and magnetic tape remembers electrical information with great accuracy; thus the two are thought of as a logical combination. The only limiting factor, which proved to be a serious impasse, was the enormous quantity of information contained in a television picture which would have to be packed onto the tape.

Over five years ago Ampex Corporation undertook developing a magnetic recording system capable of handling the full television bandwidth—nearly four megacycles. The project was successful and the major networks have converted to "Videotape" (Fig. 1) recording to solve East-to-West time-delay problems, especially since Daylight Saving Time began last April (Fig. 2).

A Practical System

The commercial success of the Videotape recorder is due not only to the excellence of the picture reproduction and the ability of tape to be erased and reused, but also to the many conveniences provided by the electronic and mechanical features of the system. For example, the slow tape speed (15 ips) matches the standard professional speed of studio-type audio recorders. A single reel allows continuous recording of up to 64 minutes. Complete pushbutton controls provide for either manual or remote operation for start, stop, fast-forward, rewind and record.

The Tape Speed Problem

The tape speed was perhaps the most difficult feature achieved. In any magnetic recording system, the tape speed largely determines the amount of information which can be recorded, or the frequency response of the system. In ordinary audio recording, 15,000 cps can be recorded at a tape speed of 7½ ips. By doubling the speed, the frequency response also can be doubled. Nearly 4,000,000 cps must be represented on the tape to record a television picture. The tape speed required to attain such high frequencies would reach about 110 miles per hour. Obviously, commercial value of a tape system operating at such a rate would be nil, if only from the standpoint of playing time alone. The largest reel of magnetic tape which could be manufactured would last only minutes.

Wide-Tape, Cross Track

An extra-wide (2″) tape and magnetic recording heads whirling *across* the tape solved the problem. Four heads are mounted 90° apart on the outer circumference of a disc which rotates at 14,000 rpm; its axis is parallel to the motion of the tape (Fig. 3). The tape, as it travels past the rotating head assembly, is held to conform with the curvature of the disc. Thus, one of the four heads is always contacting the tape in a vertical sweep (across the tape). The width of each sweep is 10 mils and the separation between sweeps is 5 mils (see Fig. 1).

The effective tape speed is now determined by the head-to-tape velocity achieved by the rotating disc, which is sufficient to maintain the needed frequency response of nearly four megacycles. The 15 ips horizontal tape speed is then determined by the center-to-center distance of the recorded vertical tracks, because the tape must be pulled past the head assembly fast enough to prevent overlapping of the tracks (Fig. 4).

The audio track is recorded horizontally (linearly along the upper edge of the tape) and a control track is recorded in a similar strip along the opposite edge in conventional fashion with stationary heads. A 240-cycle wave is recorded on the control track for maintaining the exact relationship between the rotating head assembly and the reel-to-reel speed of the tape.

Each vertical (transverse) track of video informa-

t on is recorded by one of the four rotating heads as i sweeps across the tape during a time interval of 1/960 sec. Each sweep contains 16 horizontal lines of television picture information; thus 16 sweeps describe a completed field on the video screen. A vertical synchronization pulse is recorded at the end of each field (one scan of a TV picture tube, or half of one completed frame). Each 32-sweep section, then, is one finished frame of television picture, containing two vertical synchronization pulses. All of this takes place in just 1/30th of a second, as television operates at 30 frames per second.

Ampex and the RCA have entered a patent exchange agreement which will enable the standardization of Videotape parameters for both color and monochrome transmission.

Future Uses

Current discussions indicate many advantages for tape recording with closed-circuit television in industry, flow-process studies, measurement and counting, and a variety of other procedures.

Videotape can be used for scientific research to record where conditions are hazardous to man and where film may be fogged, such as in atomic radiation studies, providing an accurate record of events in a form that is immedately available for repeated examination. Importance for closed-circuit recording also will be recognized by the educational, medical and military fields. Research programs are now being considered to investigate recording and reproducing radar signals, an application which appears to be highly compatible with this type of mechanism.

Looking further into the future, there are some who foresee small Videotape recorders adapted for use at home—for preserving favorite television programs —for making home-movies with a practical-sized electronic camera.

FIG. 2. VIEW OF VIDEO RECORDING room at CBS Television City in Hollywood shows five video recorders together with associated electronics racks and monitor screens. Although early models of the recorder cost $75,000 each and "Scotch" brand video recording tape costs more than $300 a roll, use of the tape and recorders for delayed telecasts makes possible substantial savings as compared to kinescopes, and offers the public better television picture quality.

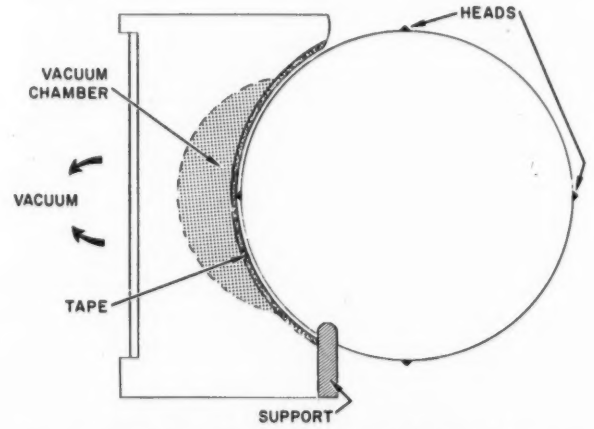


FIG. 3. CROSS-SECTIONAL DIAGRAM of rotary heads and vacuum guide.

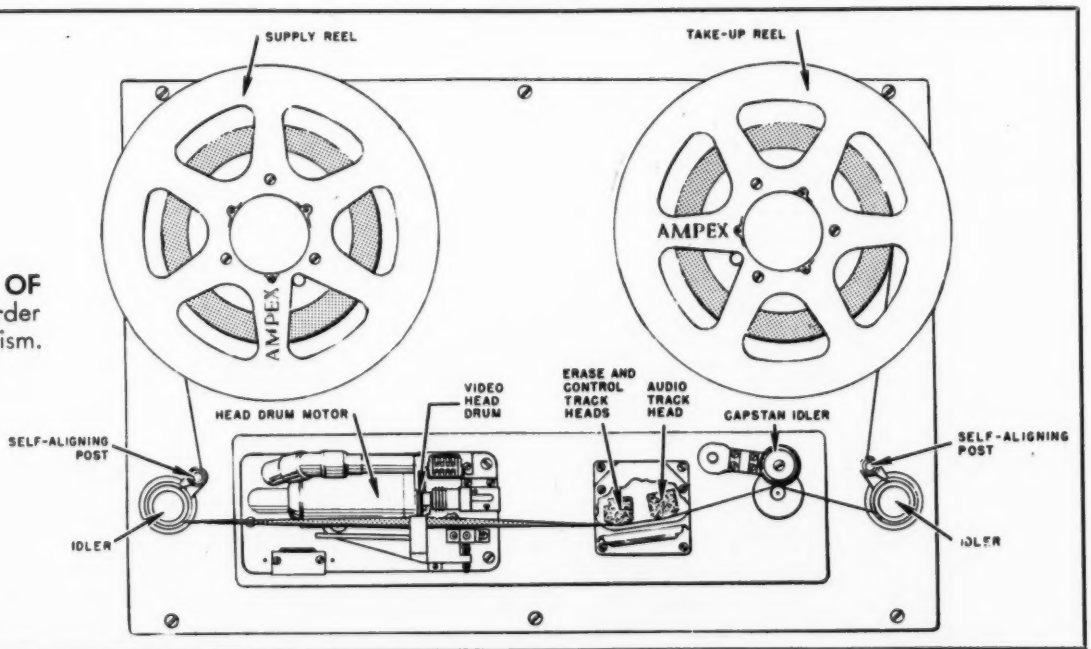
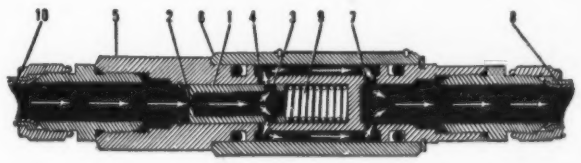


FIG. 4. LAYOUT OF video tape recorder transport mechanism.

Constant Flow Regulators

Constant flow regulators permit the speed of actuation of hydraulic aircraft accessories to be clearly regulated even when hydraulic and back-pressures vary. The basic difference between these and fixed orifice regulators is that the rate of fluid flow in fixed orifices varies as the square root of the pressure differential across the orifice, while a constant flow regulator maintains an approximate constant flow rate regardless of upstream and downstream pressure.

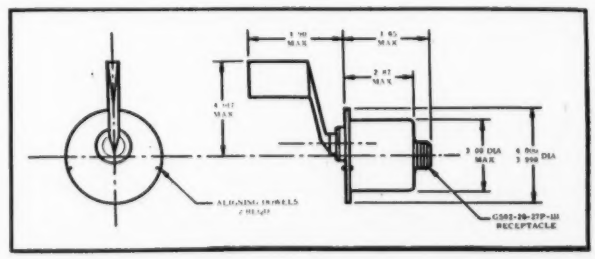


In Fig. 1 fluid passes through the orifice (2) into the piston (1) and is exhausted through the slots (3) to the annulus formed by the body (5) sleeve (6). Larger ports (7) exhaust the regulated fluid to the component line (8) to be serviced. Pressure drop which increases with increase in flow, is independent of the hydraulic system pressure. When the pressure drop reaches the point (Fig. 2) where the piston (1) is pushed inward to compress the spring (9), the piston movement restricts the opening between the piston skirt slot (3) and the body ports (4), resulting in a constant rate of fluid flow into the regulated flow line. (*From 8-page brochure, Waterman Engineering Co., 725 Custer Ave., Evanston, Ill.*

For more information circle **101** on inquiry card.

Angle of Attack Transducer

New Model 2562 conforms to MIL-T-25627 (USAF), and consists of vane, heated for de-icing, geared to two output synchros. Damping is maintained at 0.5 of critical by simple viscous type mech-



anism. Recovery time for 63% of a step input at 110 knots is only 0.075 second, and sensitivity is 0.2° from 90 knots to 125 knots and 0.1° from 125 knots to mach 3.0. Overshoot: 0.5° maximum when vane is released from a 3.0° deflection at 110 knots at sea level. Accuracy: 0.25° from 90-125 knots and 0.2° from 125 knots to Mach 3.0 at sea level. Temperature: —54°C to 93°C on the housing, and 150°C on the vane and mast. Will withstand accelerations up to 10G. (*From 2-page bulletin 2562, G. M. Giannini & Co., Inc., 918 East Green St., Pasadena, Calif.*)

For more information circle **102** on inquiry card.

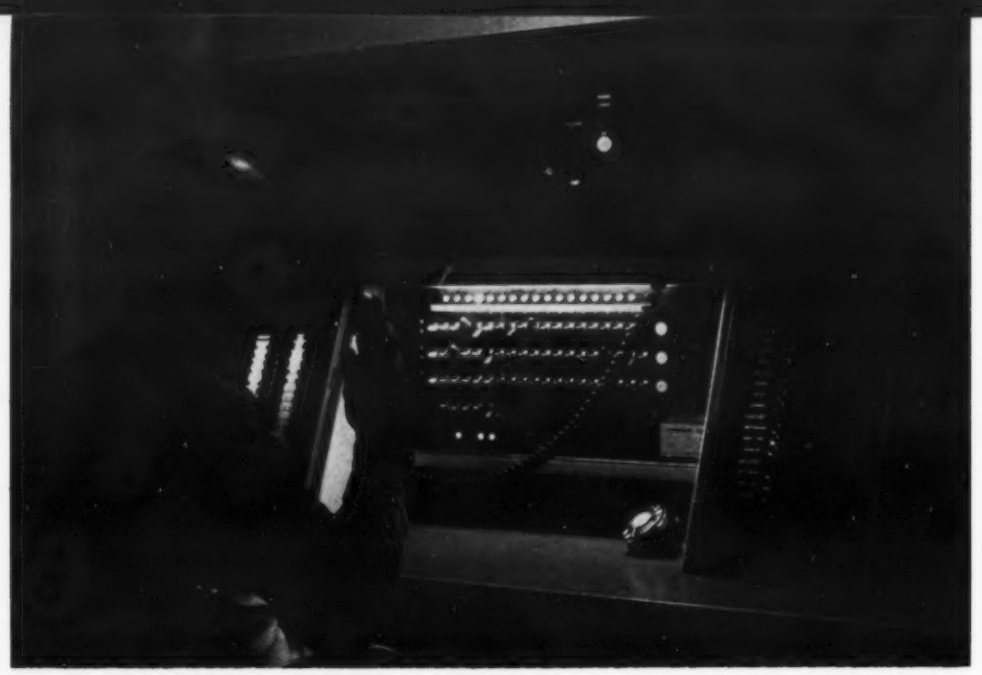


FIG. 1. FIRE CONTROL CENTER console is a clearing point for incoming and outgoing communications. (Official U. S. Navy photograph.)

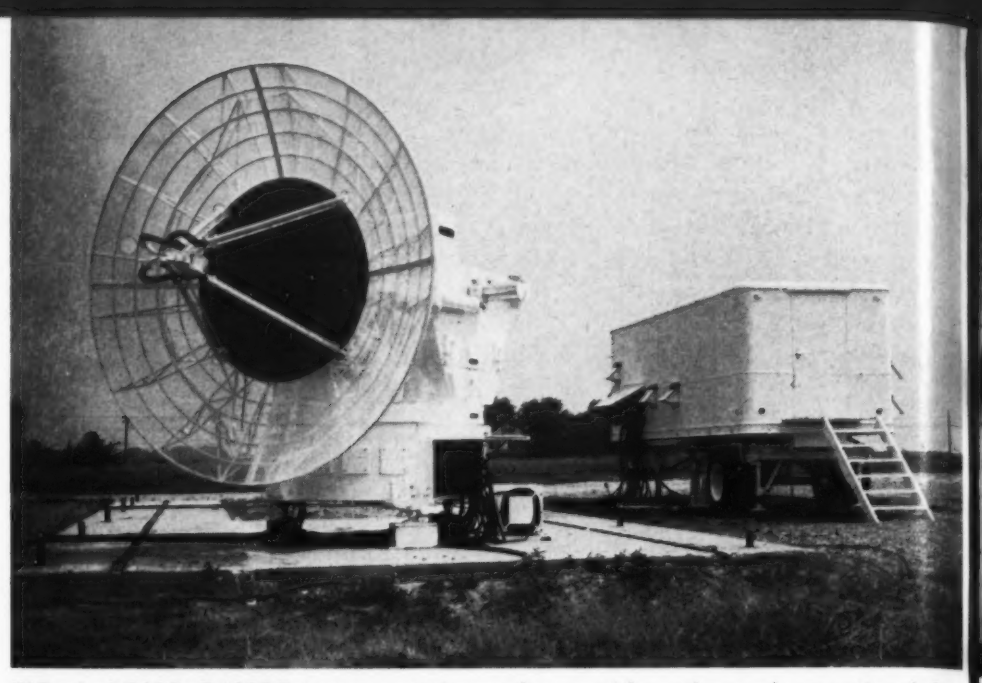


FIG. 2. LONG RANGE instrumentation radar provides advanced operational features in TDU. (Photo courtesy RCA.)

GUIDED MISSILE AUTOMATION

A. B. SMEDLEY
RCA, Camden 2, N. J.

Flash Red

A FLEET of enemy bombers, or perhaps a single enemy missile, is detected by one of the numerous warning stations associated with the SAGE system spanning the North American continent. A signal is sent to the TDU (Talos Defense Unit) (Fig. 1) where data-handling and computing machines decode the information and analyze the number of attackers, their location, course and speed of approach.

Next a scheduling and programming computer decides the logical points of interception. It then starts machinery to load the missiles onto launchers and fire them at the proper time and in the proper direction.

In this stage—still without the lifting of a human hand—the blast-proof concrete-and-steel cell doors (Fig. 3) swing open to release the missiles the computer has selected. The cells have reinforced concrete walls two feet thick and are so constructed that, should one of the missiles go off by mistake, the blast would go upward through the roof rather than horizontally to detonate the other missiles.

As a cell is opened, one of the launchers circles to face it and sends a small cart down a railed bridge to the door. Swiftly the missile is loaded on the cart and rolled onto the launcher.

Now the launcher swings to the desired position for firing. After an automatic check-out—and at the proper time—the projectile is fired. All this is done automatically.

There are two stages of flight after the initial upward thrust. First the missile follows a guidance beam to the vicinity of the target. This beam is from a version of RCA's precision, long-range, high-power instrumentation radar (Fig. 2) which has been tested by the U. S. Bureau of Standards and found to be the most accurate radar in existence. Second, as the missile approaches the target, a secret "homing" device senses its presence and "locks on" to the target for the kill (Fig. 4).

The Missile

The "Talos" missile (Fig. 3) is about 20 feet long, 30 inches in diameter and weighs 3,000 pounds. It is accelerated by a large solid fuel booster rocket some 10 feet long, jettisoned when the missile reaches cruising speed. The 40,000-hp ramjet engine, using kerosene as fuel, then ignites and provides thrust to keep the missile at constant speed throughout its flight. An automated "traffic light" tactical test system, designed by Bendix Aviation Corp., shows green when all Talos components have passed inspection. A red component light identifies any malfunction for the attention of technical personnel.

Although exact present capabilities are classified, the basic design of the Talos system is said to provide for extension of capabilities with a minimum of modification to assure that the system will have continued effectiveness against present and future hostile air threats.

The Development Team

A new era in the history of military automation begins with the completion of the Talos Defense Unit—the first fully-automatic weapon system for firing and controlling guided missiles, now in the hands of the Army for evaluation.

FIG. 3. TALOS MISSILE shown on the automatic launcher. Two missile cells are visible. (Official U. S. Navy photograph)

FIG. 4. TALOS MISSILE closing in for "kill." (Official U. S. Navy photograph.)

FIG. 5. TALOS DEFENSE UNIT operations building houses computers and control equipment. Missile assembly building and launching pit are on the right. (Official U. S. Navy photograph.)

Designed, developed and built by the Radio Corporation of America as prime contractor at the White Sands (N. M.) Proving Ground, it applies the capabilities of the Talos missile (developed by the Navy's Bureau of Ordnance and the Applied Physics Laboratory of the Johns Hopkins University) to land-based point defense. Subcontractors assisting RCA with TDU development were: American Machine & Foundry Co., the Automatic missile launcher; Reeves Instrument Corp., portions of the computing system; Hycon Eastern Inc., automatic missile checkout equipment; ITE Circuit Breaker Co., Philadelphia, Pa., mechanical parts of guidance pedestal; McKiernan-Terry Co., mechanical portions of tracking radar pedestal; and C. H. Leavell & Co. of El Paso, construction contractor at White Sands Proving Grounds.

Originally, TDU was scheduled for Air Force Control but former Defense Secretary Wilson's 1956 edict shifted control of the land-based weapon system (Fig. 5) to the Army, which accepted custody from the Navy at White Sands Proving Grounds in October 15, 1957.

Operating Features

Highlights of TDU operation are:

1. *Coverage*: The Talos range is sufficient so that each Defense Unit near a city or military base can engage a threat from any direction. This range (classified information), together with its high and low altitude capabilities, give Talos the greatest coverage of any local defense system in existence.

2. *Firepower*: TDU uses early warning information from radar networks and other sources for midcourse guidance. Time-sharing, or multiplexing of major components of the system, enables a single Talos Defense Unit to engage several targets simultaneously, controlling many missiles in the air at the same time.

3. *Kill probability*: High overall system accuracy and warhead lethality (either high exposive or nuclear) assure high kill probability.

4. *Accuracy*: Precision high-power, long-range radars; electronic computers; programmed missile guidance techniques and a precision missile homing seeker assure high accuracy at short and long ranges and high and low altitudes.

5. *Reliability*: By use of highly-reliable components, redundancy, multiple data channels and automatic fault by-pass features, high reliability is assured. In case of component failure, system operation can continue by by-passing that component.

6. *Self-Checking, Ease of Maintenance*: Automatic system checkout equipment is built into the Talos Defense Unit, providing system check-out in a few minutes. Should trouble exist, it is quickly isolated and corrected by replaceable plug-in modules (Fig. 6).

7. *Personnel Exercising*: Built-in equipment feeds in various problems on tape to simulate actual engagements, providing a method of maintaining a high state of personnel training and overall combat effectiveness.

Human Engineering Features

A most significant aspect of the system is RCA's attention to human engineering. The Fire Control Center, heart of the TDU, is not only built for completely automatic operation, but optionally can be manned by only a few people at human-engineered consoles which provide striking visual displays of information.

Operators can easily observe and monitor each engagement. The main fire-control console shows a continuous picture of the status of several engagements simultaneously. A three-color (blue, red, and green) video display screen, based on RCA's techniques of commercial color television, provides the graphic display.

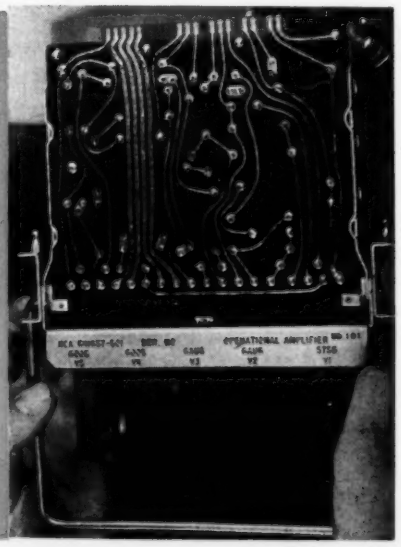
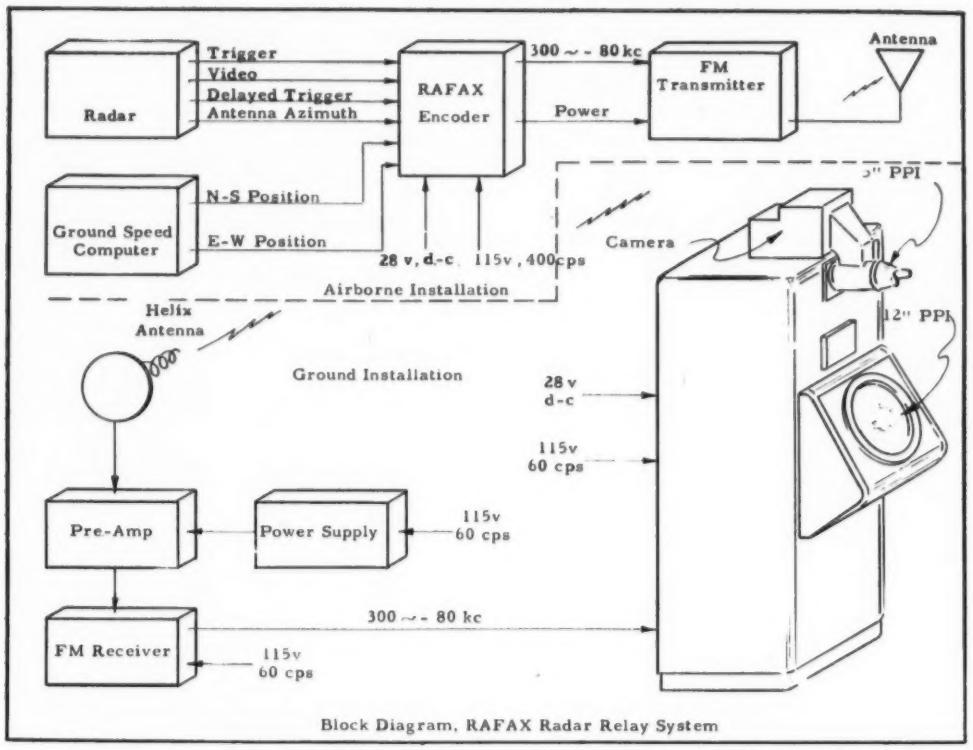


FIG. 6. REPLACEABLE plug-in printed-circuit module for rapid replacement in Talos installation (Photo courtesy RCA.)

NARROW BAND RADAR RELAY SYSTEM



Block Diagram, RAFAX Radar Relay System

Fig. 1. Mechanical-optical scanner reads out information from airborne radar PPI for transmission over narrow-band radio link to ground installation.

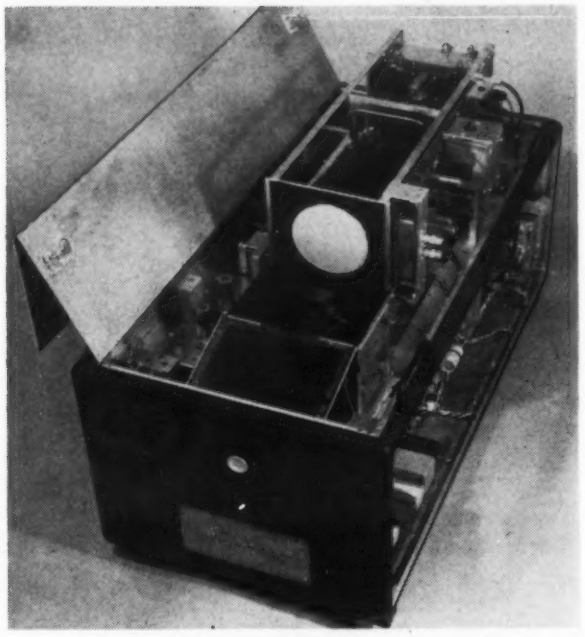


Fig. 2. Optical system of airborne encoder is enclosed in a light-tight case.

The decoder accepts the encoded signal from the communications link and recreates it for PPI presentation. The indicator is capable of accepting normal "raw" video or narrow band video. Two separate video amplifiers are used, and two separate sweep generator systems are built in. The system also provides for relaying radar PPI pictures over a single telephone or radio-telephone channel.

For more information on RAYFOX circle **205** on inquiry card.

Conversion of airborne radar information to narrow-band video and azimuth information (which then can be relayed to the ground by radio link) is performed by a new equipment, Rayfax, developed by Haller, Raymond and Brown, Inc., State College, Pa., a division of Topp Industries. Other applications exist at airports where it is desired to present a radar PPI picture in the tower although the radar itself may be as much as 10 miles distant. The encoded signal transmitted by radio link is fed into a decoder/indicator which recreates the original display. Continuous photographic recording of the display is also possible from a separate 5″ PPI tube.

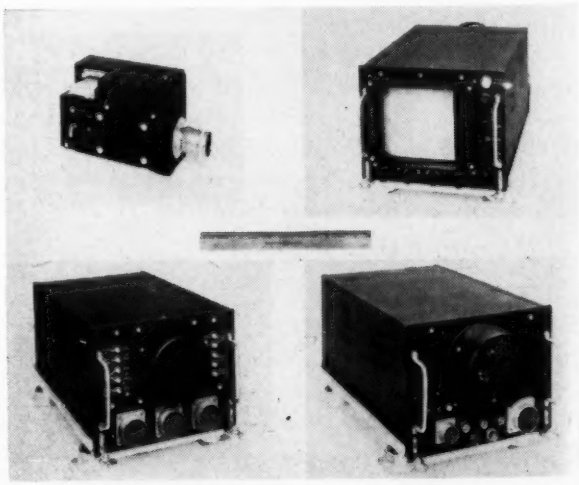
Radar video is stored as intensity modulated signals on the face of the cathode-ray tube (Fig. 2), "read-in" being accomplished at the usual radar rates, "Read-out" is accomplished just fast enough to detect significant changes in the signals stored on the cathode-ray tube. The signals are read out by a mechanical-optical scanner and photomultiplier. The output of the phototube is the desired narrow-band video signal. In addition to radar video signals, provision is made to include radar sync pulses, range marks, North marks and antenna-rotation information. Bandwidth requirements are computed from antenna rotation rate, range resolution, and beamwidth. Video and sync pulses are passed through a bandwidth compressor which generates a narrow-band video signal of about 1200-cps bandwidth.

A servo system accepts radar antenna pedestal information and generates (1) a sine wave with frequency proportional to antenna rotation rate and (2) a North mark (which occurs each time the antenna passes North). The rotation rate signal is nominally 60 cps, below the passband of communications link, so it also is impressed on a carrier. A mixer unit combines the signals and transfers them to the communications link (Fig. 1).

The encoding scanner contains a lens which is so located that it focuses a small arc of the circular trace onto a slit. Light passing through the slit strikes a photomultiplier tube. As the scanner rotates, it looks at successive elements of the circular trace. The output of the photomultiplier is a signal which is a slowed down version of the original video signal. A magnet mounted in the scanner generates a sync pulse for each scanner rotation and the pick-up head is positioned so that the timing of the sync pulse is coincident with the beginning of a new video train. North marks are generated each time the radar antenna passes North, by a microswitch located either in the antenna pedestal or in a servo which follows antenna rotation. The modulator unit does not run continuously, but is gated on whenever a target pulse is generated by the standardizer. A tachometer geared directly to the antenna shaft or mounted in a servo system following the antenna, generates a signal with frequency proportional to antenna speed.

TV CAMERA CHAIN

System of sub-miniature components meeting Military Specifications consists of camera head, camera control, picture monitor, power supply and remote control units. Designed for airborne and other military applications where human observers are not practical, the system offers a resolution of 100% modulation at 600 lines, capable of reproducing ten shades of gray on RETMA test chart. On primary power of 115v, 400c, the TV standards are 625 lines, 50 fields, 25 frames with 2:1 interlace. On conven-



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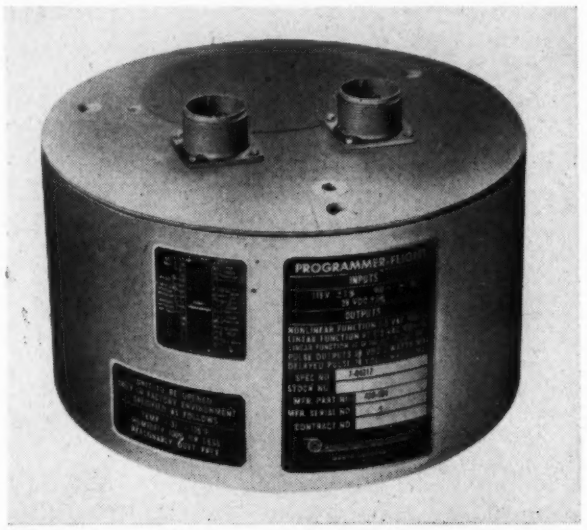
tional 115 v 60c power, TV standards are 525 lines 60 fields, 30 frames, 2:1 interlace. The camera head weighs 5 lb; total weight of all components 64.4 lbs. The system is a development of Allen B. Du Mont Labs. Inc., 35 Market St., East Paterson, N. J.

For more information circle **206** on inquiry card.

FLIGHT PROGRAMMER

Model 426-001 Flight Programmer provides variable voltage-versus-time outputs to perform various linear and non-linear functions in the planned flight of missiles. A typical program can consist of sequential on-off contacts to regulate valves, attitudes and headings of a guided missile or a drone plane, but can be used for any application requiring variable output and a constant time base.



Desired functions are etched as lines and bars on a copper-clad epoxy glass laminate moving in spiral tracks cut in the programmer housing. The laminate can be driven by sprocket holes, similar to 35-mm film, punched on the edges. In addition to pulse functions, reverse and stop information, the non-linear function, carried by the program, wipes across a linear potentiometer wrapped on a cylindrical form. This potentiometer is free to rotate as the etched function line passes by it, thus rolling contact is assured. When a new function is desired, a new circuit is etched on the pre-punched blank, eliminating the need for cam design and machining.

The voltage and pulse-function timing, controlled by the moving circuit, can be held to accurate and repeatable values because of the resolution which is attainable on the lengthy laminate. Separate functions, individually programmed on a clutch-driven etched disc, are available by which delayed pulses can be selected at any time during operation.

Operating on 28v dc, and 115 v, 400c three-phase ac, and weighing 8 lbs, the programmer unit, developed by Western Design and Mfg. Corp., Santa Barbara Airport, Goleta, Calif., has been tested in a vibration environment of 12G's from 10-2000 cps.

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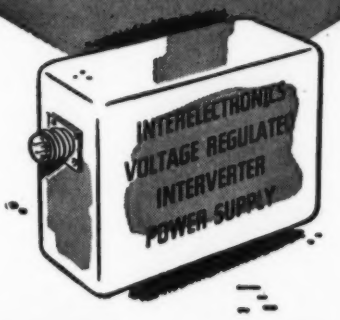

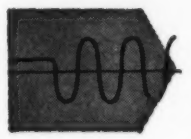

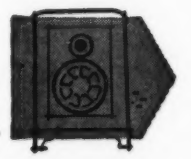

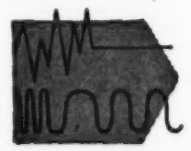

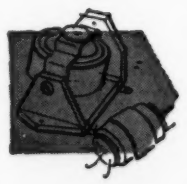

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U. S. Air Defense Center, Ft. Bliss, Texas

NIKE MISSILE TRAINING at the US AAA & GM School, Fort Bliss, Texas, features methods as up-to-date as the subject matter. Missile control units normally dispersed over square miles are physically concentrated for economy and speed in training but the "big picture" also is skilfully presented. (Missile silhouetted in color at left is the new NIKE—Hercules now supplementing the NIKE-Ajax at Army installations. All photos courtesy U. S. Army).

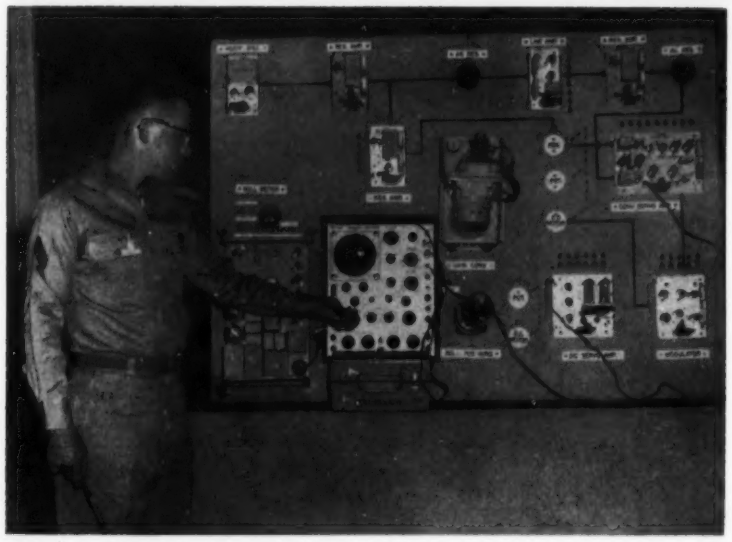

FIG. 1. (UPPER PHOTO) TEACHING AID demonstrator in guided missile electronic maintenance comprises a missile simulator and normal checkout test equipment (right) with "bread-boarded" guidance unit (left) which shows circuit waveforms at significant component checkpoints.

FIG. 2. (LOWER PHOTO) PRESETTING OF MISSILE'S roll-position gyro is vividly demonstrated, using AG Demonstrator constructed from the greater portion of the Section AG Presetting System and a roll position gyro from a missile. An oscilloscope displays the signals that accomplish the actual presetting.

FIG. 3. SUPERSONIC WIND TUNNEL demonstrator displays shock wave formation and configurations at speeds to Mach 2.

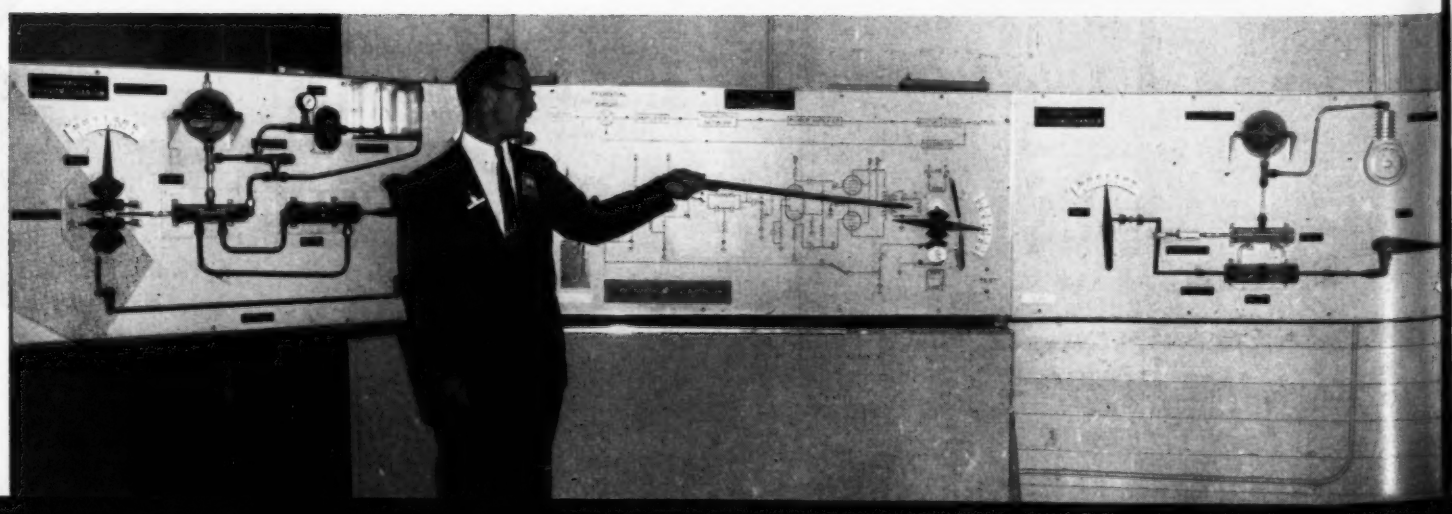

FIG. 4. SERVOMECHANISM PRINCIPLES are illustrated by three breadboard aids which depict (left to right) hydraulic, electronic, and pneumatic servos.

ETRAINING

FIG. 5. ELECTRONIC CONSOLES USED IN BATTERY CONTROL AREA are removed from trailers and set up in one building to show sequence of events during a Nike-Ajax engagement at one station only. Note how consoles are tied in with trailer illustrations to conserve equipment and to establish an understanding of how many operations in several trailers are coordinated.

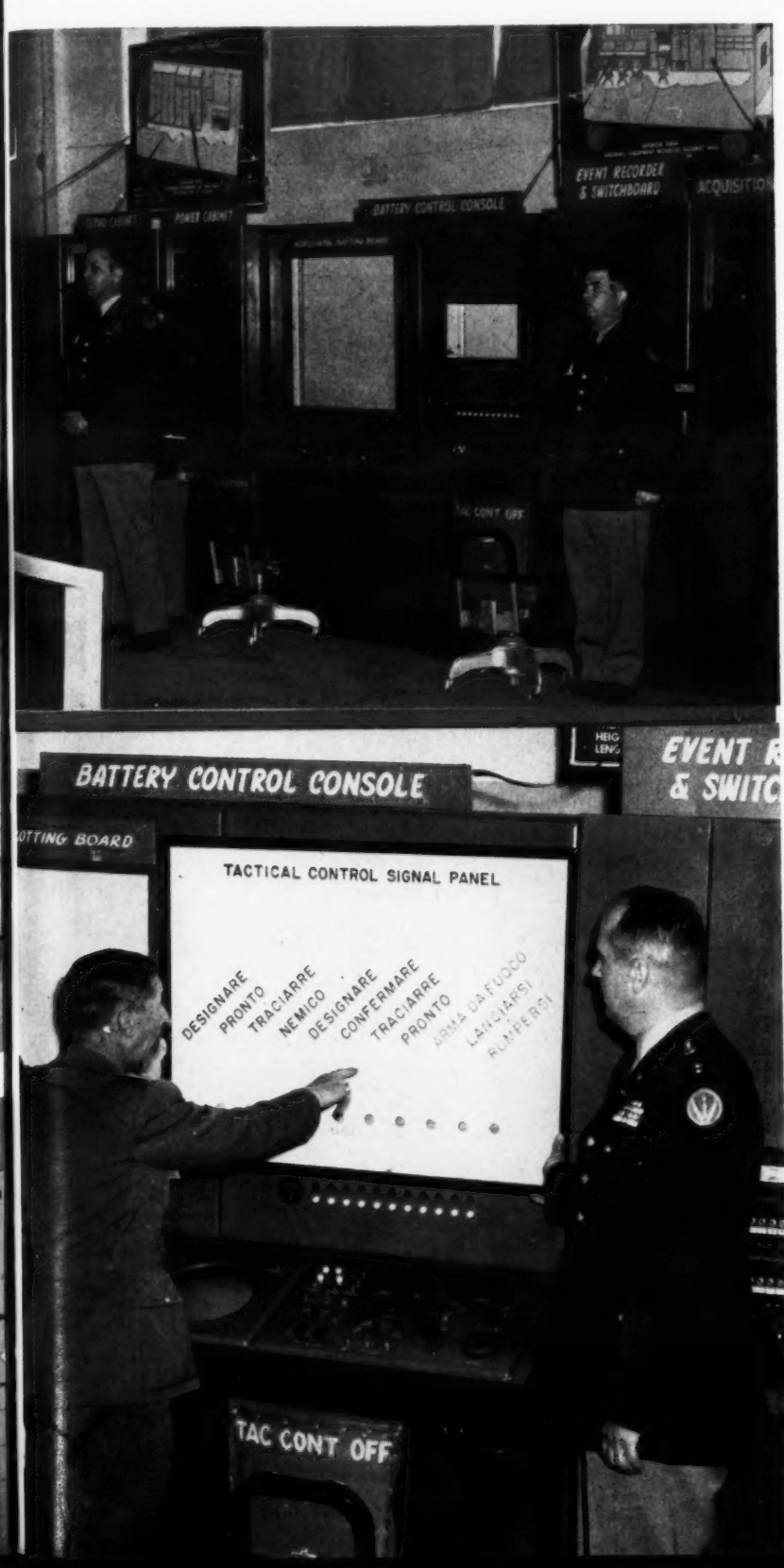

FIG. 7. GENERAL CONCEPTS of stable platforms in operational missiles are demonstrated on a stabilized platform salvaged from an obsolete missile. Many training aids are designed by the instructional staff.

FIG. 8. A LAUNCHING CONTROL PANEL, a section control panel, a test saddle, and a launcher positioning unit are assembled in one room for operator training. A small launcher-and-missile mockup is designed so that the missile moves up the launcher rail when appropriate fire orders are transmitted. The console on the left simulates the electronic equipment normally found in the battery control area. The entire sequence of events, the actions necessary in each alert status, and the duties of personnel at various stations during alerts are illustrated.

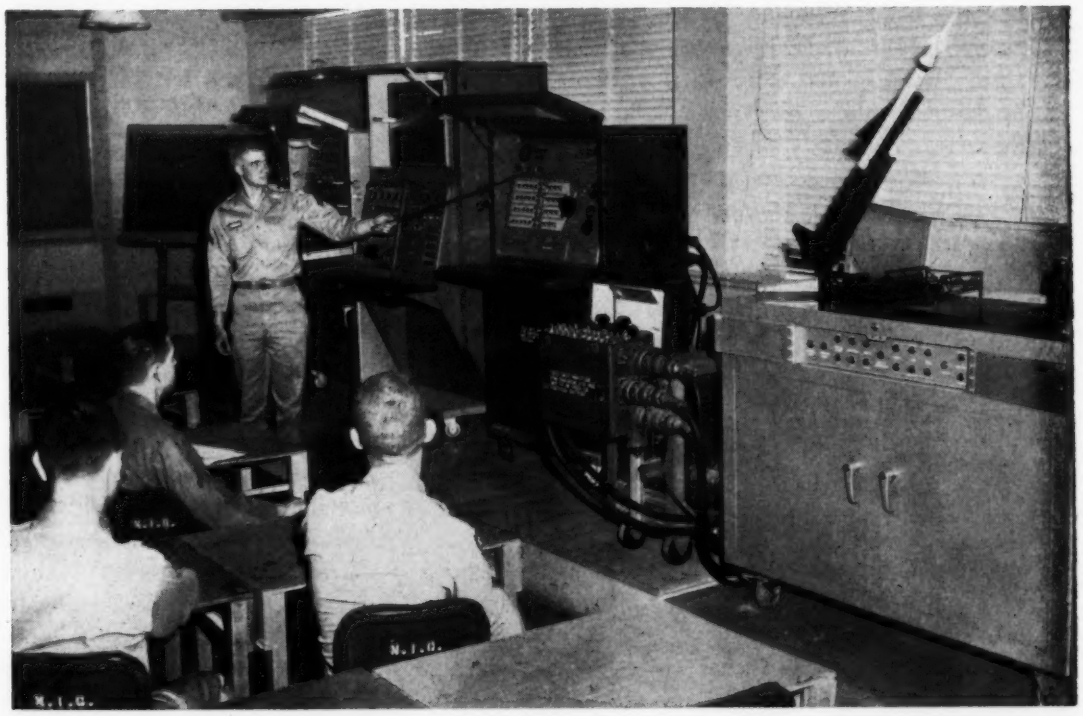

FIG. 6. VISITING NATO OFFICER traces tactical control panel operation. Various signal lights and switches, identified on a removable chart in the observer's own language, help overcome the language barrier.

Microwave Attenuation Measurements

SHERMAN A. RINKEL
Chief Design Engineer
Polytechnic Research & Development Co., Inc.
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W. E. WALLER

FUNDAMENTAL quantities such as voltage and current are defined in terms of the basic physical dimensions of mass, length, time and charge. Other quantities relating to network behavior, however, such as input impedance and attenuation, can be defined only with reference to the over-all system in which they are measured. It is obvious, for example, that the input impedance of a four terminal network cannot be specified without knowing the load impedance. Similarly, the attenuation of a network cannot be defined without reference to conditions external to the network itself.

This dependence on input and output conditions is well illustrated if attenuation is compared with another term, insertion loss, with which it is often confused. Attenuation is defined as the ratio of the power a *matched* generator would deliver to a *matched* load to the power actually received by the load when the net-work in question is inserted between the generator and the load. In decibels this is expressed as

$$A = 10 \log_{10} \frac{P_A}{P_L}, \qquad (1)$$

where P_A is the load power without the network present and P_L the load power after insertion. The subscript $_A$ denotes that this is the maximum available power from the generator. Implicit in this definition is the requirement for specifying the characteristic impedance, since, in general, a network will exhibit different attenuation in matched systems of different characteristic impedance. Attenuation, so defined, includes both dissipative and reflective loss.

Theoretically, attenuation also can be defined in terms of voltage or current ratios, although the power relationship is particularly desirable for ease of measurement at microwave frequencies. The formula for attenuation, using the voltage relationship, is of course,

$$A = 20 \log_{10} \frac{V_G}{V_L}, \qquad (2)$$

Insertion loss is exactly analogous to attenuation, except that the generator and load impedances are completely arbitrary (need not be matched to each other or to the network). In decibels, insertion loss can be expressed as

$$L = 10 \log_{10} \frac{P_G}{P_L}, \qquad (3)$$

where P_G is the load power without the network and P_L is the load power after insertion of the network.

How these definitions differ must be clearly understood since their indiscriminate use can lead to substantial errors. For instance, a dissipationless step-up transformer introduced into a matched line will introduce reflective attenuation. The same transformer introduced into a mismatched line can increase the power transfer, thereby exhibiting a negative insertion loss which differs considerably from its attenuation.

Attenuation, then, is a "standardized" term roughly analagous to "Mu," the amplification factor of a tube, in that for this value to be attained in practice, conditions must be exactly as defined. Insertion loss, on the other hand, is similar to "gain," in that it expresses the results obtained in a practical or experimental circuit, where conditions are never ideal.

FIG. 1. PRD TYPE 705 BROADBAND Microwave Oscillator uses Kylstron tube to cover 7,000 to 11,000 mc range.

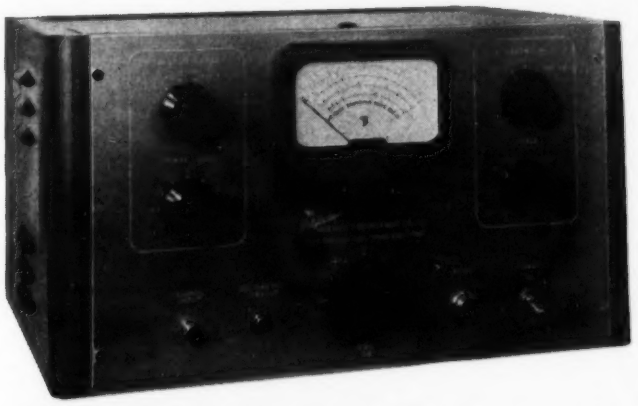

FIG. 2. PRD TYPE 277 STANDING Wave Amplifier amplifies and accurately measures resistance change of bolometer or rectified output of detector crystal. Also supplies bias current to bolometer.

FIG. 3. PRD TYPE 801 KLYSTRON Power Supply provides heater, beam, and reflector voltages to oscillator unit.

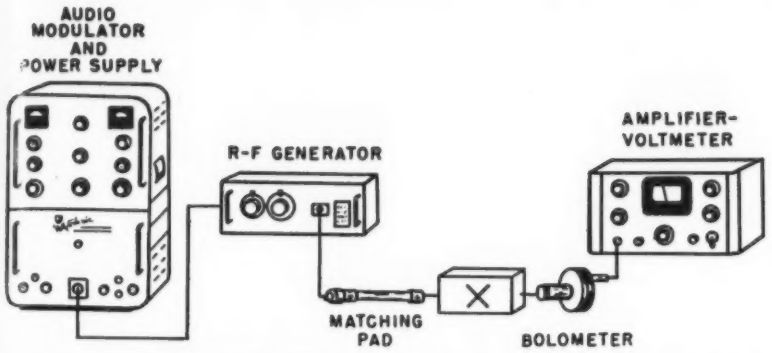

FIG. 4. ATTENUATION measurement by direct method. Power delivered to the bolometer is detected with and without attenuator X in the line. Ratio of these powers gives attenuation directly. Matching pad and stubs on bolometer must be adjusted to give low VSWR to avoid mismatch errors.

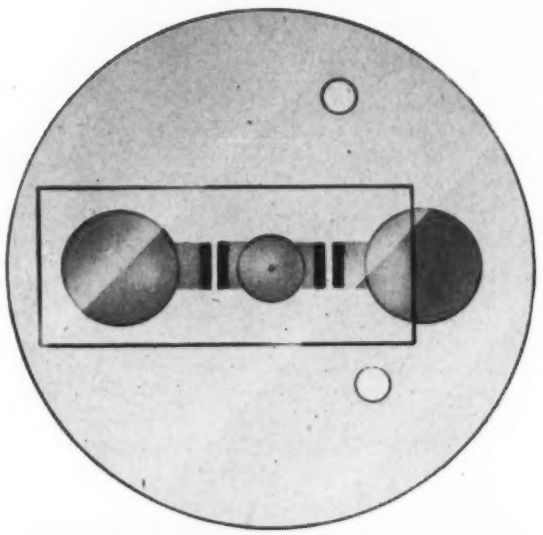

FIG. 5. BOLOMETER element for UHF power measurement. (Courtesy The Narda Corp., Mineola, N. Y.)

Methods of Measurement

The methods of measuring attenuation can be lumped into three general categories. These are:

1. Direct or insertion methods,
2. Substitution or slide-back methods, and
3. Impedance measuring methods.

Although the use of pads and tuners for matching purposes is not specifically called for in any of the methods described below, it should be understood that they are needed if accurate results are desired.

(Care should be taken in both the direct and substitution methods with the calibration of audio attenuators. These are usually labeled in decibels of audio power. Therefore, when used with square-law detectors, the decibel change indicated is twice the actual change in r-f power.)

Direct Methods

The direct method of measuring attenuation follows from the definition of attenuation. The power delivered to a matched load from a matched generator is detected with and without the network under test inserted in the line. The ratio of these powers then gives the attenuation directly. Although absolute power measurements would be suitable, only relative power measurements are necessary, since it is only a ratio that is required. This procedure places the burden of accuracy solely upon the detecting system. It is essential, therefore, that the law of the detector be accurately known as well as the precision of its associated indicating equipment.

One of the most convenient and precise ways of measuring attenuation using this method is shown in Fig. 4. The r-f generator is modulated at an audio rate to permit a-c amplification of the detected signal. A bolometer is used as the power sensitive element and a narrow-band, high-gain amplifier-voltmeter—such as a standing wave amplifier—is used to measure the detected bolometer output. The amplifier usually delivers the d-c bias current for the bolometer.

The useful range of measurement in this arrangement is limited by the thermal noise of the system at the low end and by the allowable deviation of the bolometer from square-law operation at the high end. It has been shown that the theoretical minimum detectable signal level from a bolometer over a 25 cycle bandwidth is about —63 dbm. In practice, the noise contributed by even a well designed amplifier will reduce this to approximately —58 dbm. At the high end, a bolometer can be operated at power levels up to —7 dbm, with a 2% deviation from square-law. If a minimum signal to noise ratio of 10 db is assumed, this method will permit a 40 db range of measurement under such conditions.

This technique is quite useful for most laboratory work, since it is rapid, requires relatively little equipment, and yet offers readily obtainable accuracies of the order of 0.2 db.

References

1. E. Weber, "The Measurement of Attenuation," in *Techniques of Microwave Measurements*, edited by C. G. Montgomery, M. I. T. Radiation Laboratory Series, Vol. 11; McGraw-Hill Co., Inc., N. Y. 1947, pp. 804-853.
2. B. Steinman, "Measurement of Attenuation" *Handbook of Microwave Measurements*, edited by M. Wind and H. Rappaport, Polytechnic Institute of Brooklyn, Microwave Research Institute, Brooklyn, N. Y., 1934, Sestion III.
3. PRD Reports, Vol 3, No. 1, pp. 3-5.

Substitution and impedance-measuring methods of attenuation measurement will be discussed in forthcoming articles.

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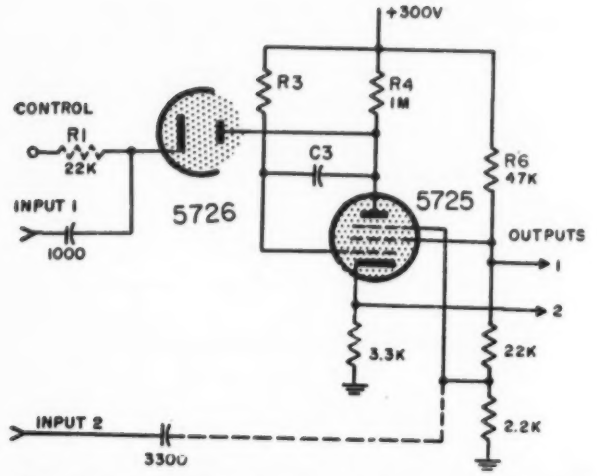


Phantastron delay circuit is often used in AFC circuits to adjust Klystron reflector electrode potentials.

Circuitry for Military Applications

MILTON H. ARONSON
Instruments Publishing Company

and

CHARLES F. KEZER
Digitronics Corporation

PHANTASTRON DELAY

Widely used in radar receivers and indicators, the phantastron generates outputs of constant amplitude whose duration is closely proportional to a control voltage. It has better precision and stability than the one-shot multivibrator. Circuit shown is NBS-BuAer preferred circuit PC56. The phantastron also can be used to generate a slow, linear sawtooth waveform, and is often used in automatic-frequency-control circuits used to adjust the reflector electrode voltage of klystron local oscillators.

Principle of phantastron operation depends on the characteristic of certain pentode tubes like the 5725 shown (a premium version of type 6AS6; subminiature equivalents are types 5684WA and 5636) to have the cathode current go to either the plate or screen, depending on the suppressor-to-cathode potential. As in other pentodes, cathode current (sum of plate and screen currents) is determined by the control grid voltage. The division of cathode current betwen plate and screen, however, is determined by the suppressor voltage. In pentodes suitable for phantastrons, plate current can be completely cut off by sufficient negative voltage at the suppressor grid; all of the cathode current then flows to the screen.

In the stable condition, cathode current is maximum because the control grid is biased positively, drawing current. Cathode is operating at about +12 vdc with respect to ground; hence the suppressor grid is negative with respect to the cathode, and plate current is cut off. All of the cathode current is thus flowing to the screen. Screen current, passing through resistor R6, drops the screen voltage to about 40 vdc. Suppressor voltage is about 3.5 v positive with respect to ground. Assuming the control voltage (V_c) is at its maximum value of 280 vdc, the plate voltage is also at this value, held there by conduction of the 5726 diode.

If a negative 15-v trigger is now applied to input 1, the phantastron shifts to an unstable state. The abrupt drop in plate voltage is passed through capacitor C3 to the grid. This grid voltage drop causes a drop in cathode current, a corresponding drop in cathode voltage, and a rise in screen and suppressor voltages. This causes cathode current to be transferred from the screen to the plate because the suppressor is now positive with respect to the cathode. This plate current further decreases the plate potential.

The action described started with a negative signal at the plate which led to increased *plate* current, which in turn caused further decrease in plate potential. This, by definition, is regenerative action, and the plate potential tends to fall rapidly. However, note that a sudden decrease in plate potential would produce a strong negative signal on the grid because the grid is capacitively coupled to the plate. This negative grid signal tends to cut *off* the plate current and raise the plate potential. Hence the plate potential *cannot* fall suddenly, but instead decreases linearly depending on the R3-C3 time constant.

A plate voltage "rundown" now occurs, with the plate voltage decreasing at a nearly constant rate. After a time determined by time constrant R-3-C3 (and by initial plate voltage value) the plate "bottoms" and can decrease in potential no further. At this time the phantastron begins to recover, with C3 recharging to its original condition. The grid becomes positive and the tube regains its initial stable condition. Cathode current rises abruptly to its original value, and the delay period ends. A recovery period must elapse, however, before capacitor C3 has completed recharging, and the plate voltage returned to its full original value. The circuit cannot be reliably triggered again until recovery is completed.

The abrupt changes in screen and cathode currents provide nearly rectangular waveforms at outputs 1 and 2. Output 1 is a positive-going waveform of 60-v amplitude; output 2 is a 15-v negative-going gate.

Duration of the output waveforms is closely proportional to the time constant R3-C3, and to the control voltage value. Control voltage range is 20 to 280 v; maximum delay time error is 0.1% of the maximum duration. Duration changes little with supply voltage changes, provided that circuit voltages and control voltage are derived from the same supply and vary together. With a common supply, a 10% change in supply voltage causes about 0.1% change in duration. A 10% change in heater voltage has the same effect. Jitter, or short-term variation in duration, is negligible in the circuit shown.

Aging of tubes causes a gradual change in duration: replacing the 5725 tube typically produces about 2% change in maximum duration. For highest accuracy the circuit should be calibrated frequently.

C3 and R3 are temperature-stable, ±5% compo-

Table 1—R3-C3. Parameters for Various Delay Periods for PC 56 and 57.

R3 megohms	C3 μμf	Minimum duration (Vc*=20v) μsec	Maximum duration (Vc=280v) μsec	Maximum recovery time [1] (Vc=280v) μsec
1.0	100	7	90	270
1.0	220	15	200	600
1.0	470	30	440	1600
1.0	1000	70	930	2700
2.2	1000	150	2000	2700
2.2	1200	180	2450	3250
3.3	1200	265	3700	3250

[1] For PC56 only; For PC57 approx. 40 μsec.
*Vc is control signal voltage

Table 2—Inputs and Outputs of PC 56 and 57

Terminal		Amplitude v	Rise Time μsec	Duration μsec	Decay Time	Impedance Ohms	Polarity
Input	1	15	0.1	1 to 5	—	—	Negative
	2	20	0.1	0.2 to 2	—	—	Positive
Output	1	60	0.2	—	0.1%[2]	≈20K	Positive
	2	10	0.2	—	0.1%[2]	≈1K	Negative

[2] In percent of maximum duration.

nents. Other resistors are ±10%, capacitors ±20%, tolerance.

As shown in Table I, recovery time (the time which must elapse before the phantastron may be triggered again) is generally longer than the delay time. In the next circuit, a cathode follower is added to reduce recovery time.

Input and outputs: See Table 2.

Control voltage, V_c: 20 v to 280 v.

Maximum error: 0.1% of max duration.

Source: NavAer 16-1-519, *Handbook of Preferred Circuits, Navy Aeronautical Electronic Equipment*, National Bureau of Standards, Washington, D. C.

FAST RECOVERY PHANTASTRON DELAY

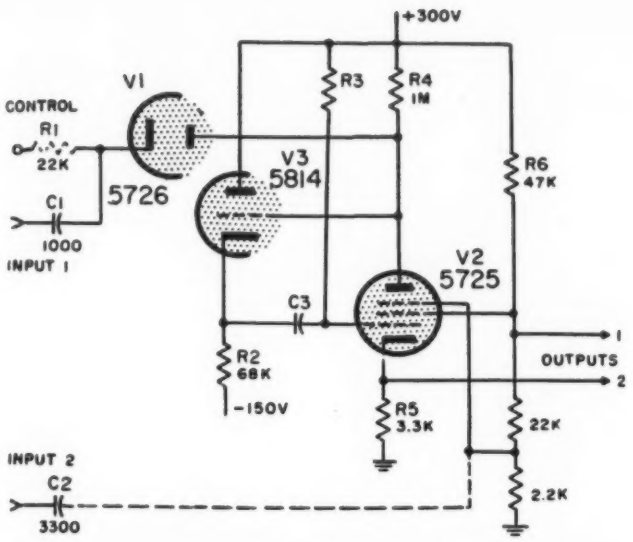
In many applications the long recovery time of the preceding phantastron circuit is not objectionable When recovery time must be reduced, a cathode follower can be added as shown to reduce recovery time to about 40μsec. Circuit is NBS-BuAer preferred circuit PC 57.

The cathode follower in this circuit couples the plate to the grid, so that the phantastron action described in the previous circuit is unchanged. However, as only tube and circuit capacitances are now present at the plate, the plate can recover more rapidly after its rundown.

The recovery time of both circuits is determined by the time for the 5725 tube plate voltage to return to its original (high) level. In the preceding circuit, recovery of the plate is slow because the capacitor C3 must recharge through the 1-megohm resistor R4. Inserting the cathode follower V3 takes the capacitor out of the plate circuit. This time-constant reduction lowers the recovery time.

Reducing the recovery time is not without disadvantages—not only is an extra tube section required (½ of a type 5814) but control voltage range is limited to the range 20-240 vdc because a minimum voltage drop across the cathode follower of 60 v is required for linear operation. Linearity of delay with input control voltage is also not as good as the preceding circuit. Maximum error is 0.5% of maximum duration; it may be reduced to 0.1% by further restricting the maximum control voltage V_c to 150 vdc.

In either circuit the control voltage source must provide a dc return path to ground to permit the clamping diode V1 to operate. Resistor R1 is needed with a low-impedance control voltage source (such as a potentiometer) to prevent short-circuiting of the



Fast recovery phantastron requires only 40 μsec between waveforms.

trigger voltage. If the control voltage source has a minimum output resistance greater than 22K ohms, R1 can be omitted.

Either circuit can be triggered by a positive pulse at the suppressor grid (input 2) because the cathode current can be switched from screen to plate by either a small increase in suppressor voltage or a small decrease in cathode voltage. Triggering the suppressor is more critical because the trailing edge of the trigger may tend to end the phantastron cycle prematurely.

The phantastron is also used to provide stable fixed delays up to 0.1 second or more in applications such as frequency dividers. It can also be made free-running by reducing the value of the cathode resistor R5.

Inputs and outputs: Same as preceding circuit.

Control voltage, V_c: 20 v to 240 v.

Maximum recovery time: 40 μsec approx.

Maximum error: 0.5% of max. duration.

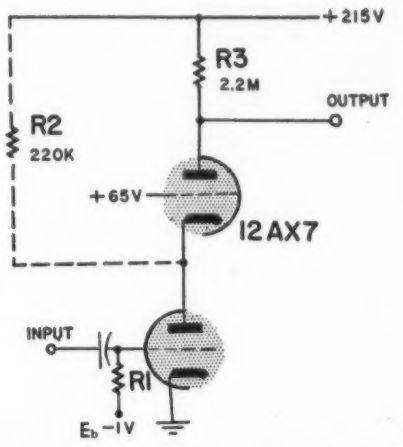
Minimum duration: See table 1, preceding circuit.

Maximum duration: Approx. 85% of fourth column, table 1.

Source: NavAer 16-1-519 *Handbook of Preferred Circuits, Navy Aeronautical Electronic Equipment*, National Bureau of Standards, Washington, D. C.

Cascode Amplifier Has Voltage Gain of 1500

The term "cascode" has been applied to the dual-triode amplifier of the type shown (with R_2 disconnected); the plate of the input grounded-cathode stage drives the cathode of the fixed-grid stage directly. The cascode exhibits pentode-like characteristics, including high internal resistance (measured in megohms; conventional triode amplifier internal resistance is of the order of 10-100K ohms).



Cascode circuit is a direct coupled amplifier with high internal resistance.

As in a pentode amplifier, voltage gain increases with increased plate load impedance (R_3). When the plate load is a resistor, however, as in the basic circuit shown (R_2 disconnected), this increased voltage gain can be obtained only by increasing plate supply voltage beyond normal practical values. Reason for this is that the mutual conductance (g_m) of the lower triode, which largely determines the voltage gain, falls off with decreasing plate current. If the plate load resistor is increased, and no corresponding increase in plate supply voltage is made, the resulting decrease in plate current produces a decrease in g_m which offsets the expected improvement in voltage gain.

The simple modification shown allows high voltage-gain to be obtained with normal B-supply voltages. Addition of R_2 in the circuit increases the voltage gain from 100 to 1200, with bias voltage E_b adjusted to maintain a drop of 20 v dc across R_3. An additional plate current of 670 μa is supplied to the lower triode through R_2., producing an increase of over 10 times in its g_m, and improving the circuit voltage gain by nearly the same factor. At first glance it might appear that R_2 is shunting the upper triode and would thus impair performance; however, the impedance at the plate-cathode junction is low and is virtually unaffected by the added resistor.

Gain: Depends on operating point; 1200 at 20-v dc drop across R_p, increasing to 1500 at 100-v drop. Gain of 1700 was obtained by incerasing R_3 to 4 megohms.

Output impedance: 7 megohms is parallel with R_3; approx. 1.5 megohms in circuit shown.

Frequency response: No lower limit; upper limit depends on capacitance load at output. Gain was measured at 500 cps.

B supply: 215 v dc at 0.7 ma. Bias voltages of +65 v and about —1 v dc also required.

Source: V. H. Attree, College of Technology, Manchester, England; also *Electronic Engineering*, April 1955.

AIR NAV—ANTI COLLISION SYSTEM

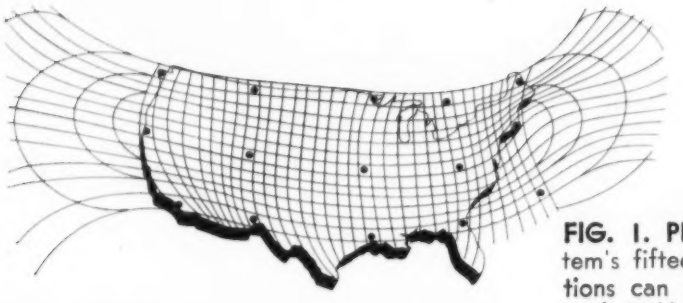


FIG. 1. PROPOSED system's fifteen ground stations can control all aircraft in U. S.

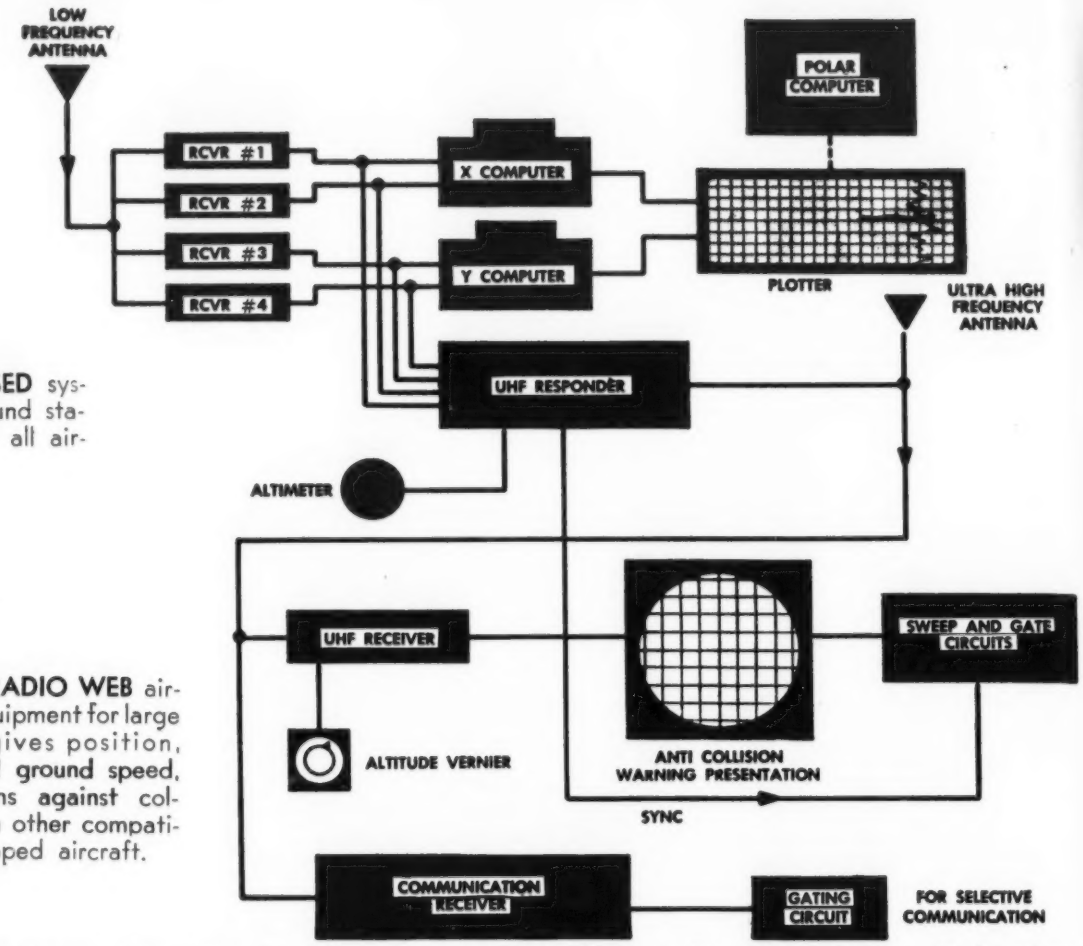


FIG. 2. RADIO WEB airborne equipment for large planes gives position, track and ground speed, and warns against collision with other compatibly equipped aircraft.

Offering promise for the interim period and for the forseeable future in the handling of air traffic loads, and capable of solving the three common system requirements (air navigation, traffic pattern control, and air collision warning for both short and long range conditions) a system has been developed by Radio A.I.R. (France). It is called RADIO WEB, and the U. S. licensee for the North American continent is Stavid Engineering Corp., Plainfield, N. J. Most of the equipment is ground-based to conserve space aboard aircraft. Fifteen ground stations (Fig. 1) are contemplated which will control all aircraft in the U.S. to a position accuracy of ½ mile in uncongested areas, and to 200 yards in controlled zones. With stations placed 2,000 miles apart, RADIO WEB is said to control trans-oceanic traffic to within five miles.

The basic system, weighing 10 lbs., is designed for small and medium-sized aircraft. It is flexible enough to handle heavy concentration of traffic in the major hub areas. It can be expanded to include a continuous graphic presentation of position track and ground speed, a relative position indicator, and provisions to feed bearing and distance information to the autopilot. Voice communication with the ground, data link for ground control, and altitude control can be added. The position indicator gives a continuous display of position, track, and ground-speed and provides visual and audible warning of compatibly equipped aircraft at the same altitude, or on a possible collision course. The pilot's vision is thus extended, electronically, fifty miles in all directions, regardless of weather or line-of-sight restrictions. More advanced equipment for large aircraft (Fig. 2) is expected to weigh about 60 lbs.

Radio signals sweeping the area between any four transmitting towers of the grid network, spaced approximately 600 miles apart, provide the aircraft with a position fix.

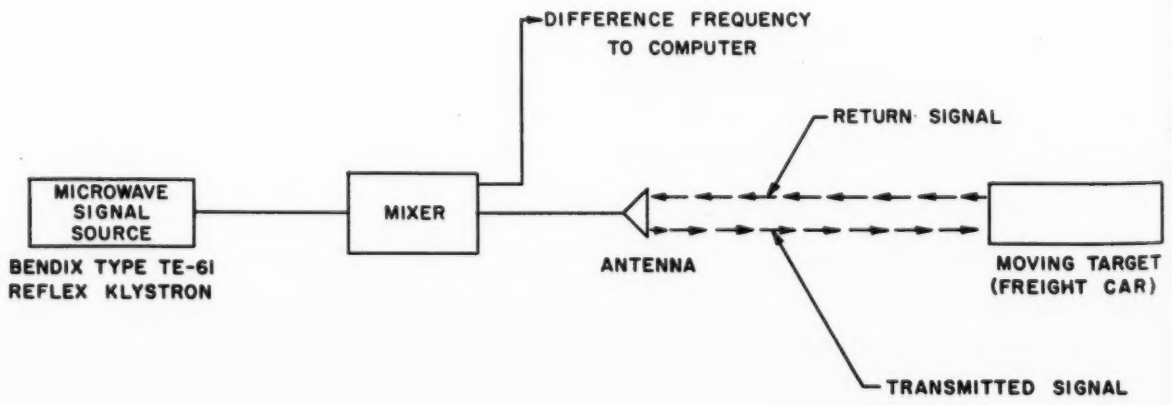
For more information on Radio WEB circle **208** on inquiry card.

BOXCAR RADAR

Doppler radar, in an ingenious industrial application, illustrates its capability for the accurate detection of low speeds. Using a TE-61 klystron tube as a fixed-tuned reflex oscillator, the difference between the transmitted frequency and that of the signal reflected from a moving target is used to accurately determine and control the speed of moving freight cars in classification or "humping" yards.

A lower-power output of 25 milliwatts at 10,525 mcs is sufficient for the limited ranges required. Doppler radars are located between the rails and when a car, rolling towards its selected track, passes over them, they transmit its actual speed to a computer. Based on this information, the computer actuates retarders along the tracks to ensure just enough speed to couple with a mating car without causing damage to the cars or their contents. The system was designed by the *Bendix Aviation Corporation, Red Bank Div., Eatontown, N. J.*

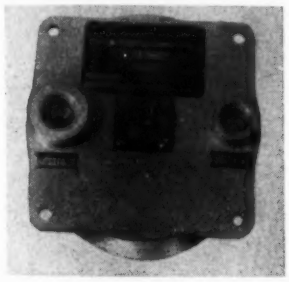
For more information circle **209** on inquiry card.



MA New Products

MACH SWITCH

New force-balance direct-acting mach switch for new Air Force jet, saves as much as 2 lb. weight. Approximately 4" dia. and 1½" in depth it provides an accuracy of ±2% to 70,000' altitude. Will open or close at

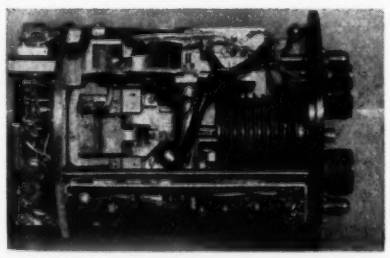


selected mach points up to mach 2, with freedom from contact flutter under environmental conditions.—*Burton Mfg. Co., Colorado Ave. at 26th St., Santa Monica, Calif.*

For more information circle **301** on inquiry card.

MACH METER

New pressure-actuated instrument with inputs of static pressure, pitot pressure and stagnation temperature, generates output functions of mach number in combination with stagnation temperature, and true air speed.



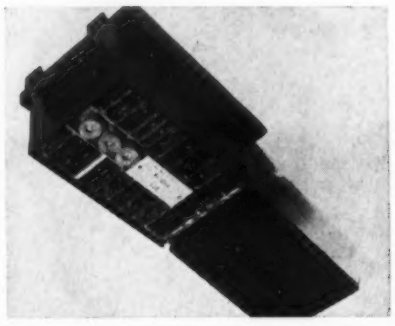
Model No. 1003-0100 covers range of 100-1000 knots, with accuracy of ±¾ knot. Mach Meter No. 1022-0100 covers a Mach Number range of 0.5 to 1.5 with standard sensitivity of ±0.003. Operates at altitudes up to 60,000 feet.—*M. Ten Bosch, Inc., Pleasantville, N. Y.*

For more information circle **302** on inquiry card.

IF AMPLIFIER/AFC UNIT

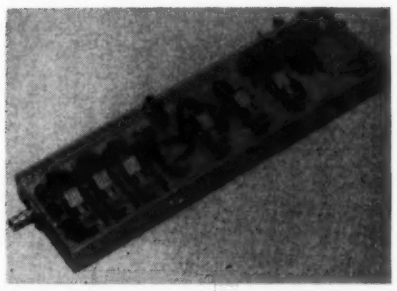
New submin unit, for a 0.1 microsecond pulse system, contains elements required for AFC including I F amplifier, diode phantastron, and an internal control for manual tuning

MAGNETIC AUTOPILOT AMPLIFIER



New miniature amplifier (here compared to non-miniaturized equal) receives steering information, performs necessary electrical operations and transmits an electrical signal to actuate the controlling mechanisms of the missile. Vacuum tubes have been replaced with magnetic amplifiers. Standard equipment on the Matador missile, the amplifier is adaptable to other missiles. The magnetic amplification modules are plug-in units and all component parts are insulated to make the units shock proof, moisture resistant and tamper proof.—*Hallamore Electronics Co. Div., Brookhurst and Santa Ana Freeway, Los Angeles, Calif.*

For more information circle **305** on inquiry card.

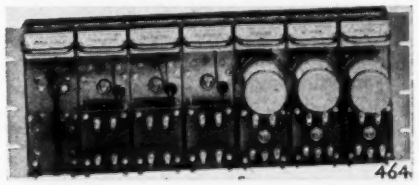


of the LO. Has sweep of 3 cps with sweep output of 45 v at adjustable level of −115 to −195 v. Dimensions 11½" x 3½" x 1". *Lel, Inc.*, 380 *Oak St., Copiague, L. I. N. Y.*

For more information circle **303** on inquiry card.

TRANSISTOR TONE TELEMETER

New TT1 tubeless 18-channel system improves system reliability for remote metering and control at a greatly reduced unit price. Sharply notched bandpass filtering permits allocation of tone channels 120 cycles apart. Tone signals can be applied simultaneously as a composite signal to any private open wire, cable radio



or microwave system, hence multiplying telemetering circuits.—*The Warren Mfg. Co., Inc.*, 10 *Lake Ave., Littleton, Mass.*

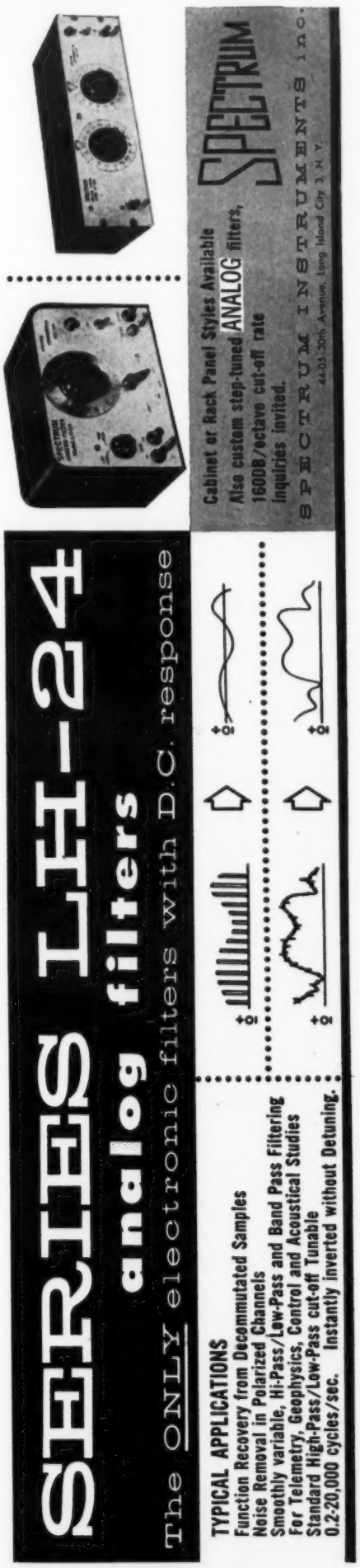
For more information circle **304** on inquiry card.

AIRBORNE TIME CODE GENERATOR

New lightweight unit for missile and aircraft instrumentation, employs transistor-driven, magnetic cores, and supplies a 16-bit, 24-hour crystal-controlled binary code to hours, minutes and seconds for recording timing marks or time codes on magnetic tape, etc. Binary code readout is once per

second at a 100 pps rate. Time can be read directly to 0.01 second and interpolated to 0.001 second. Operates up to an altitude of 70,000' and at ambients from −40°C to +80°C. Input power is 25 watts, from standard aircraft-type sources.—*Electronic Engineering Co. of California*, 1601 *E. Chestnut Ave., Santa Ana, Calif.*

For more information circle **306** on inquiry card.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SPECTRUM INSTRUMENTS inc.
Cabinet or Rack Panel Styles Available
Also custom step-tuned ANALOG filters,
160DB/octave cut-off rate
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analog filters
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For more information circle **13** on inquiry card.

NEW FAST SERVICE

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UP TO SIX
MADE TO YOUR SPECIFICATIONS
SHIPPED WITHIN ONE WEEK

NEW ENGLAND TRANSFORMER COMPANY
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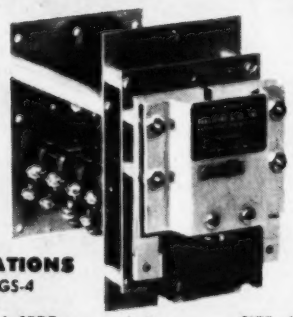
For more information circle **37** on inquiry card

HIGH ALTITUDE

BALLOON

CONTROL INSTRUMENTS
require MAXIMUM Performance
MINIMUM Size - Weight - Power Drain

BRAILSFORD AGS TIMERS ARE UNMATCHED IN THESE BASIC REQUIREMENTS



IF YOU HAVE A TIMING PROBLEM WHERE SIZE, MASS AND POWER DRAIN ARE CRITICAL READ THESE

SPECIFICATIONS
Model AGS-4

NUMBER OF CIRCUITS—4 SPDT • SIZE—3 IN. X 2¼ IN. X 1¾ IN.
WEIGHT—6.1 OZ. • POWER INPUT—.008 AMP. @ 6 V.D.C.
SPEED REGULATION ±1.0% @ ±50.0% VOLTAGE SHIFT
ALSO AVAILABLE 1—2 OR 3 CIRCUITS

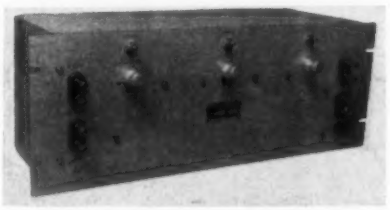
WRITE FOR LITERATURE
BRAILSFORD & CO. INC.
670 MILTON ROAD • RYE, N.Y.

ENGINEERING DEVELOPMENT BRAILSFORD MANUFACTURING
SUB FRACTIONAL WATT D.C. MOTORS SIGNALLING SYSTEM COMPONENTS

For more information circle **16** on inquiry card.

COORDINATE CONVERTER

New model ER-95 converts polar to Cartesian coordinates by a sine-cosine potentiometer linked to a null-seeking servo. The value of "R" impressed across the pot is resolved into its quadrature components according to the position of the pot, this position being determined by the "Θ" input. Speed of pot positioning is 360°/sec and "Θ" sensitivity is 0.5 mv dc/de-

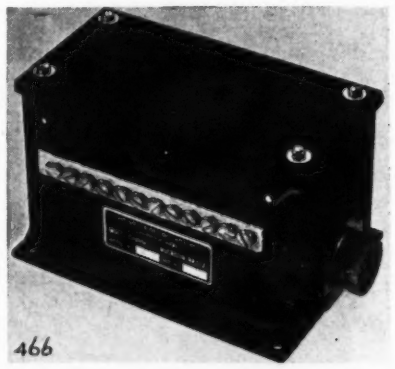


gree. Power required by self-contained power supply is 50 watts at 115 volts, 60 cps. Overall size is 6" x 7" x 19" and the unit may be either rack mounted or used as a bench instrument.—*Mandrel Industrial Insts., Div. of Mandrel Industries, Inc., P. O. Box* 13243, *Houston, Texas.*

For more information circle **307** on inquiry card.

RESISTANCE THERMOMETRY SYSTEM

New system specifically designed for severe missile and aircraft test environments permits continuous



monitoring of temperatures at 12 points within missile. Its power comes from missile instrumentation supply. —*Arthur C. Ruge Assoc., Inc.,* 733 *Concord Ave., Cambridge, Mass.*

For more information circle **308** on inquiry card.

CONTINUOUS VARIABLE DELAY LINE

New model #503 offers maximum in flexibility and meets all applicable Mil. Specs. Entire range from zero to maximum delay covered by a single control shaft, may be locked at the desired delay by locking device, and can be used as a component in equipment with a fixed delay, or as a con-

tinuously variable test unit. Attenuation is 2.5 db, resolution better than 1/1000 of maximum delay of 4.0μ sec, maximum rise time 0.76μ sec, impedance is 220 ohms. Outside dimensions 7¼" x 1" x 1⅝". Meets all applicable Mil. specs.—*ESC Corp.,* 534 *Bergen Blvd., Palisades Pk., N. J.*

For more information circle **309** on inquiry card.

TRIODE FOR INSTRUMENTATION RADAR

New hard tube triode F-6920 modulator has a peak plate current and hold-off voltage of 150 amperes and 35 K. V respectively. Is intended for

switching applications within the range of .002 duty factor and 15 microseconds pulse length. Anode is forced air cooled, capable of dissipating 10 KW at ambients of 50° and the filament operates over a range of 11.0 to 11.9 depending on peak plate current requirements.—*Components Div., International Telephone and Telegraph Corp.,* 100 *Kingsland Rd., Clifton, N. J.*

For more information circle **310** on inquiry card.

MULTI-CIRCUIT TIMERS

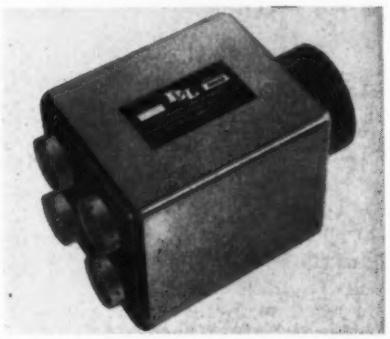
New time delay relays and sequence program switches have six load circuits in the repeat-cycle timer and five load circuits in the reset-cycle unit; meet Mil-specs for use in guided missiles, fire controls, gun purge doors, flashers, radio, radar and cam-

era controls, latitude in timing cycles ranges from split seconds to hours. Motors operate on 115 volts, 400 cycles. Switches are SPDT type.—*Automatic Timing & Controls, Inc., King of Prussia, Pa.*

For more information circle **311** on inquiry card.

SYSTEMS SWITCH

New hi-speed rotary switch with up to 90 circuits per pole can be sequentially switched at any constant speed up to 1800 times per minute. Typical switching combinations in a single unit are 45 contacts at 1200 times per min. plus 90 contacts at 600 times per min. plus 30 contacts

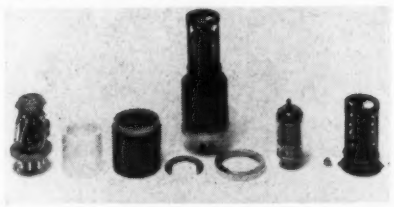


at 1800 times per min. Insulation resistance exceeds 100 megs. Case is hermetically sealed. Power required is less than 40w single phase 400c 115v ac. Operating temperatures range from −55°C to +100°C at atmospheric pressure of 0.05° hg.—*Instrument Dev. Labs., Inc., 67 Mechanic St., Attleboro, Mass.*

For more information circle **312** on inquiry card.

PLUG-IN CIRCUIT SYSTEMS

Eighteen new ruggedized building blocks includes cathode followers, flip-flops, and phantastrons. All meet



shock, vibrations and temperature requirements of MIL-E-5272A.—*Engineered Electronics Co., 506 E. First St., Santa Ana, Calif.*

For more information circle **313** on inquiry card.

TUNABLE X-BAND MAGGIE

New 5780, an integral magnet, air-cooled, pulsed type magnetron, continuously tunable over the 8500 to 9600 mc. range. Capable of over 300

kw (peak) output, the 5780 is used in short pulse, X-band and is 10.00" x 8.250", weighs approx. 15½ lbs.—*Bomac Labs., Inc., Salem Rd., Beverly, Mass.*

For more information circle **314** on inquiry card.

Circle **17** on inquiry card. ⟶

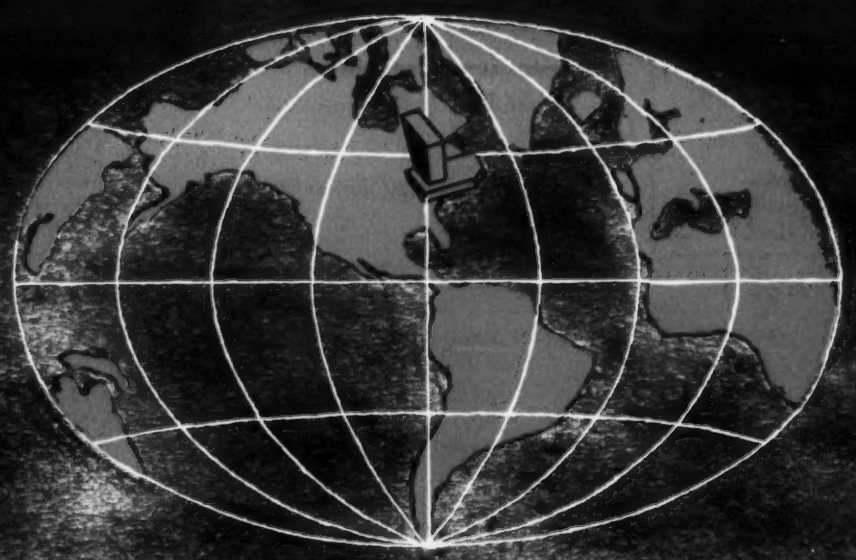
Fourth International

AUTOMATION

EXPOSITION & CONGRESS

New York Coliseum

June 9 to 13, 1958



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TRANS-SONICS

REG. T. M.

ELECTROSET* PRESSURE SWITCH

Remotely adjustable without a Servo System

Shown actual size

SPECIFICATIONS

RANGE: Adjustable 0 to 15 psia (0 to 760mm Hg)

REPEATABILITY: ±1mm Hg.

ACCURACY: ±2mm Hg.

ACCELERATION: 50 g in any direction

VIBRATION: 25 g to 2000 cps.

WEIGHT: 14 oz.

TEMPERATURE RANGE: −65° to +160°F.

SWITCHING CURRENT: 1 ampere resistive load

Operates under severe environment from atmospheric pressure to vacuum with accuracy of 2mm Hg.

The Electroset Pressure Switch offers a new and easier way to calibrate and set a pressure switch from a remote position. The contacts are automatically adjusted simply by applying the desired switching pressure and momentarily energizing a solenoid. When the solenoid is de-energized, one contact is securely clamped while the other contact remains free to move with changes in pressure. Once set, the switch will open at pressures below the calibrating pressure and close at pressures equal to or above the calibrating pressure.

The Electroset Pressure Switch is vacuum sealed, isolated from dirt, moisture or corrosive fluids, including the fluids used to actuate it. It is ideally suited for industrial process control applications where an adjustable switch must be located in a remote or inaccessible location or where the switch must operate in an atmosphere which would degrade the performance of a non-hermetically sealed unit. Among military applications are arming of warheads and control of aircraft or missiles. Write for Technical Bulletin 1570 to Trans-Sonics, Inc., Dept. 12, Burlington, Massachusetts.

TRANS-SONICS

Precision Transducers

*TRADEMARK

For more information circle **18** on inquiry card.

RANGE MARKER

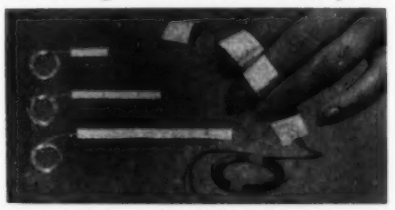
New miniature precision range and timing marker uses ultrasonic propagation in fused quartz and is said to give stable time delays from 0.5 to 10 μsec. A single input pulse results in multiple output pulses calibrated in microseconds or yards. Cases are

hermetically sealed, shock and vibration proof. Length 1½", dia. ⅜". Mounting is through a BNC type flange.—*Microsonics Inc., Hingham Industrial Center, Hingham, Mass.*

For more information circle **315** on inquiry card.

THERMAL RIBBONS

New ribbon thermistor detects temperature of the surface to which it is attached. Suited for aircraft, missiles, and electronic equipment, accurately monitoring or controlling temperatures of surface areas. Resistance element of high nickel content alloy wire

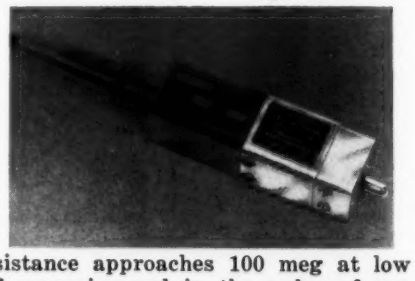


is encased in a flexible outer covering less than .020" thick. The ribbon may be cemented to flat, cylindrical, or irregular surfaces. Self adhering types are also available.—*Minco Prod., Inc., 740 Washington Ave. North, Minneapolis 1, Minn.*

For more information circle **316** on inquiry card.

VOLTAGE DIVIDER

New model 91-7A is a capacitance divider with step-down ratio of 100:1 converting the .001-3 v range of 91-B voltmeter to 0.1 to 300v. Frequency range is 500 kc to 500 mc with self-resonance at 900 mc. High shunt re-

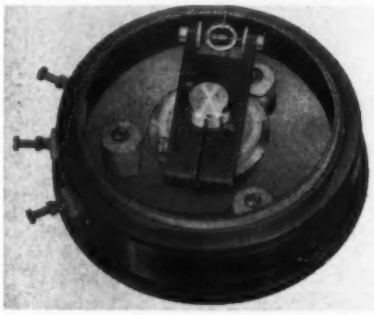


sistance approaches 100 meg at low frequencies and in the order of one meg at 100mc. Shunt capacitance is 2.5mmf.—*Boonton Electronics Corp., 738 Speedwell Ave., Morris Plains, N. J.*

Fo more information circle **317** on inquiry card.

SINGLE-TURN POT

New 1000 Series single-turn pot features standard linearity of 0.1%, (0.2% for miniatures) with Dynamic balance centering around the contact. The arm is rigidly clamped and balanced with respect to the shaft. Contact assembly is mounted in jeweled pivots and balanced with respect to the arm. Only very light spring pres-

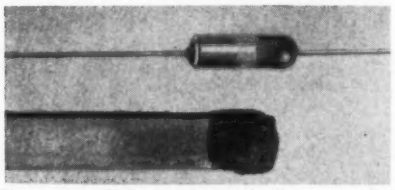


sure is needed under severe environmental conditions. Meets NAS-710. 5,000,000 cycle life, 2,000 cycle vibration at 30g's, and speeds from 1,000 to 3,425 rpm with starting torques as low as 0.1 in. oz.—*Chicago Aerial Industries, 1980 Hawthorne Ave., Melrose Park, Ill.*

For more information circle **318** on inquiry card.

TANTALUM CAPACITORS

New Type WT feature small size and operating temperature range of −20°C to +50°C with adequate storage life. Satisfactory performance above 50°C is possible where shortened capacitor life can be tolerated.

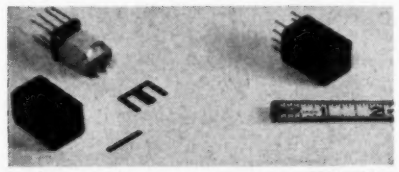


The capacitor case and the attached lead form the cathode terminal and are available in insulated and non-insulated construction. The anode tantalum wire extends through the teflon bushing to a solderable lead.—*Aerovox Corp., New Bedford, Mass.*

For more information circle **319** on inquiry card.

MINIATURIZED TRANSFORMERS

Designed for mounting on printed wiring boards, core structures of these new transformers are nickel-iron laminations for the audio frequency units, and ferrite for those in the

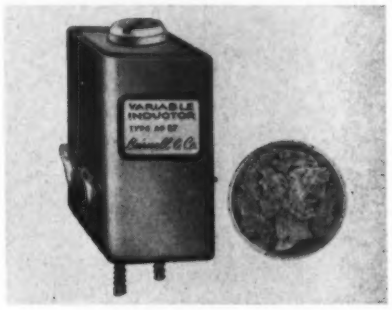


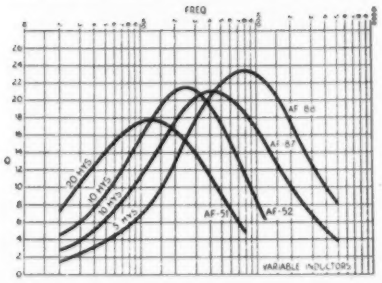
carrier frequency ranges. Windings are of polyurethane-insulated copper wire, separated by Mylar.—*Stromberg-Carlson, Telecommunication Div., Rochester 3, N. Y.*

For more information circle **320** on inquiry card.

VARIABLE INDUCTORS

New subminiature type AF-87 covering 30 to 500c, and type AF-88, 50-1000c, for low-frequency high inductance applications, measure 1¼" x



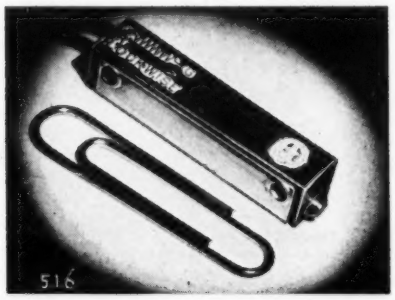


34/64" x 34/64", are available in all inductance values to 80 Hys, meet Mil-E-15305 A specs.—*Burnell & Co., 45 Warburton Ave., Yonkers, N. Y.*

For more information circle **321** on inquiry card.

TRIMMING VDR

New tiny "Padohm" precision voltage-dividing resistor for pad or trim resistance functions is screwdriver-adjusted, is available in resistance



values from 100 to 20,000 ohms, and standard over-all resistance tolerances of plus or minus 10% with 2% standard linearity. Type L rated at 0.25 watt, derated to 0 power at 105°C; Type H, 0.40 watt, derated to 0 power at 135°C.—*Clarostat Mfg. Co., Inc., Dover, New Hampshire.*

For more information circle **322** on inquiry card.

RESISTORS

New high temperature type PW-20 features lug terminals and radial leads and combines a unique design with high degree of automatic assembly, is used for actual wattage dissipation of 20w or less, and where operation is at high ambient temperature.—*International Resistance Co., 401 North Broad St., Philadelphia 8, Pa.*

For more information circle **323** on inquiry card.

GYROSCOPE

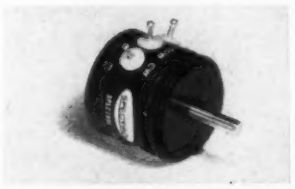
New KR-8 light-weight, integrating rate gyro with self-contained temperature control operating on the heat-of-fusion principle is designed to maintain temperature of 80°C with a tolerance of ⅓ degree. The control also can be designed to maintain other temperatures. Tests are said to show

a maximum wander of 6/10ths degree for a period of more than four hours. 3" long, 2"dia., and weighing 1¼ lbs, KR-8 has a dc permanent magnet type torque motor requiring no reference current. Torque motor coil construction requiring no shaft and inherently resistant to vibration and "g" loading, the motor speed is 24,000 rpm. Motor power is 3-phase, 6.3v, 400 cycles, 1.75w.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **324** on inquiry card.

PRECISION POTENTIOMETER

New Model 700 single-turn pot has resistance values up to 125,000 ohms and ±0.2% linearity. Incorporates up to 6 sections ganged on a single shaft,



with class 5 Ball Bearings at both ends, first pot section 0.687 inch long and each additional cup 0.500 inch in length. 9 additional terminals are available per section, can be tapped at nearly any angle and tap-welded to a single turn of the resistance wire.—*Spectrol Electronics Div. of Carrier Corp., 1704 South Del Mar Ave., San Gabriel, Calif.*

For more information circle **325** on inquiry card.

RADIAL LEAD CHOKES

New series of 42 coils have inductance values from 0.47 to 10,000 micro-henries, are hermetically encapsulated in molded alkyd plastic. All coils are said to easily conform to MIL-C-15305A specifications, and are suitable for either automation equipment or hand insertion. Leads are spaced at 0.100 inch increments.—*Delevan Electronics, East Aurora, N. Y.*

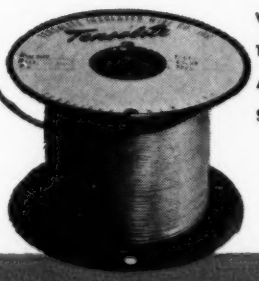
For more information circle **326** on inquiry card.

A MINIATURIZATION MIRACLE *by Tensolite*

Here, literally is the world's smallest 300 Volt, High Temperature, stranded hook-up wire! So tiny it can be threaded through the eye of a needle! Expressly designed to give you top performance where SPACE LIMITATION is an important factor! TEFLON® insulated and stranded for super flexibility . . . REDUCE space requirements . . . REDUCE assembly time . . . REDUCE rejects!

TENSOLITE is proud to announce this giant step forward in the endless search for greater miniaturization. Our Factory and Field Engineers will assist you with unusual or specific applications where miniaturization is a must. Write today for complete descriptive literature and samples.

HERE ARE SOME OUTSTANDING FEATURES AND CHARACTERISTICS



VOLTAGE RATING: 300 Volts
TEMPERATURE RANGE: −90°C to +250°C
AWG SIZE: #36
STRANDING: 7/44 (4% SPC)
O. D. CONDUCTOR: .006
INSULATION: Teflon
WALL THICKNESS: .0045"
SPARK TEST: 1000 Volts RMS
O. D. FINISHED WIRE: .015

® DUPONT

Tensolite INSULATED WIRE COMPANY, INC.
198 MAIN STREET, TARRYTOWN, N. Y.
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For more information circle **19** on inquiry card.

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For more information circle **14** on inquiry card.

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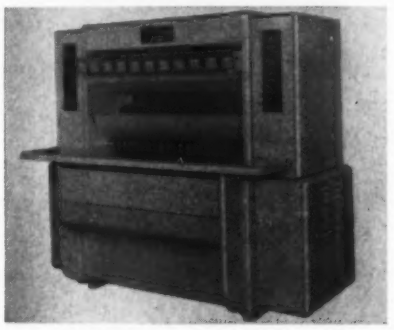
AUTOMATIC WHITEPRINTER

New machine for processing ammonia type diazo whiteprints, the Revolute Star has speeds up to 45 fpm with automatic separation of

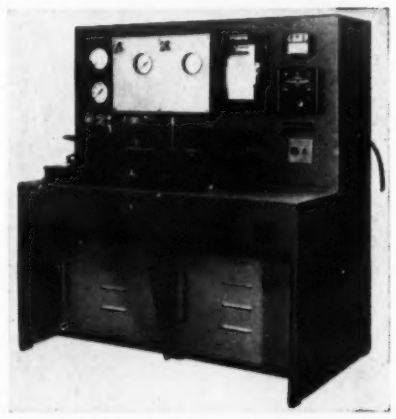


original and sensitized material. It has a 4000w light source, is fast in printing, efficient and uniform.—*Paragon-Revolute Corp., 77 South Ave., Rochester 4, N. Y.*

For more information circle **327** on inquiry card.

DEAD-SPACE MEASURER FOR HYDRAULIC SERVO VALVES

New Hydraulic Servo-Valve Dead-Space Measuring Device measures dead space under actual operating

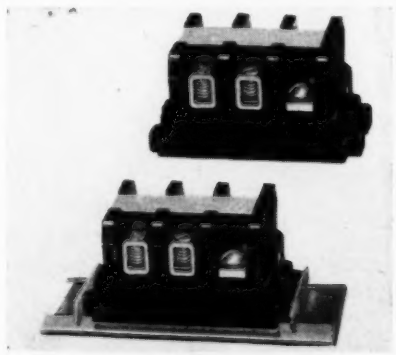


pressure conditions, yields exact data on edge conditions and location of face of land.—*Hesse-Eastern Div., 136-138 Mt. Auburn St., Cambridge 38, Mass.*

For more information circle **328** on inquiry card.

SECTIONAL TERMINALS

New medium duty sectional pressure blocks can be assembled "on the job" without fastening hardware

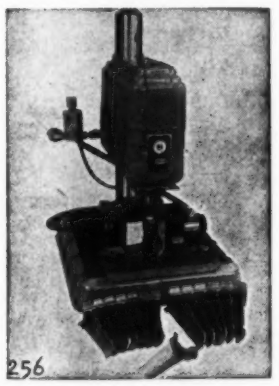


or factory-pre-assembled to specifications. Tubular contacts for stripped wires or combinations of two or more wires are available with screw contact for #18 thru #8, or clamp contact for #22 thru #10 wire. Strap screw contacts for terminal-ended or looped wires accommodate any $\frac{5}{16}$" or narrower ring or spade terminal for #6 or larger stud. Contacts are $\frac{7}{16}$" centers.—*Buchanan Electrical Products Corp., Route 22, Hillside, N. J.*

For more information circle **329** on inquiry card.

MARKING MACHINE

New high-cycle short-stroke Automark was developed for marking delicate aircraft parts; features many

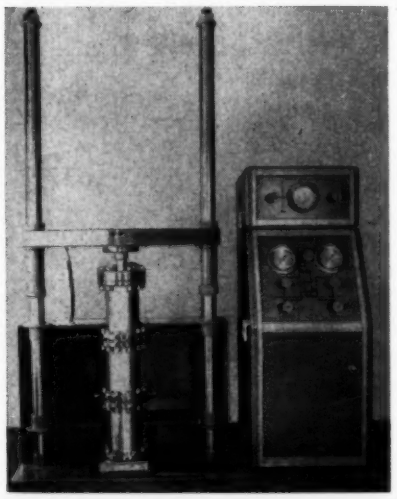


light vibratory strokes (about 41 to 45 per second), as opposed to one heavy impact stroke.—*Defiance Machine & Tool Co., 1920 S. Vandeventer Ave., St. Louis 10, Mo.*

For more information circle **330** on inquiry card.

SHOCK TESTER

New model HY-6000 accurately simulates shock experienced by equipment or components in aircraft, turbines, missiles, and rockets. Produces ex-

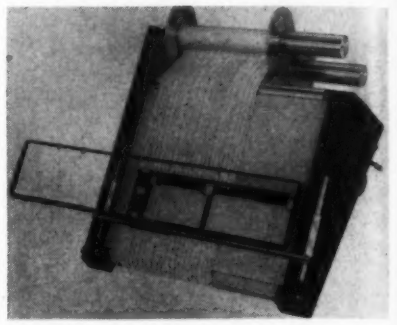


tremely high loads instantaneously, with thrusts up to 40,000 pounds. Shock pulses are controllable for both waveform and acceleration and deceleration level, whether the waveform is square, triangular, cosine, or sine pulse. Also available in kit form.—*Rochester Div., Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.*

For more information circle **331** on inquiry card.

OSCILLOGRAM READER

New Data Reader, Model R-1 is capable of handling any number of linear or non-linear channels, correcting for linear or non-linear scale factors, and automatically correcting for the zero line location of each channel. Features film widths 0-16",

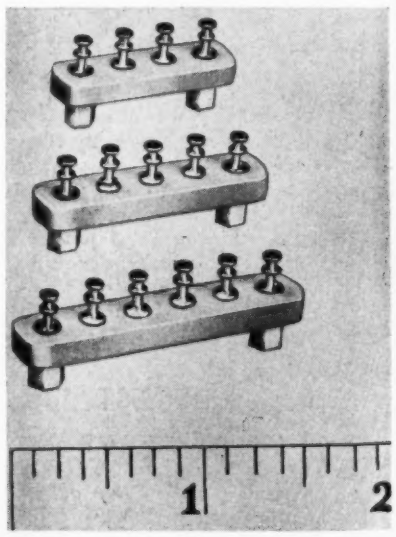


6" max. dia. expendable strawboard rolls can be loaded in the darkroom; pushbutton operation-forward and reverse from panel or foot switch; special linearizing variable scale quick individual channel reference line location; vertical variable scale, X, Y type reading system, adjustable speed drive for scanning or reading variable transformer control.—*Gerber Scientific Inst. Co., 162 State St., Hartford 1, Conn.*

For more information circle **332** on inquiry card.

CERAMIC TERMINAL BOARDS

New type 2303-1, 2303-3 boards of grade L5 silicone impregnated ceramic, $\frac{5}{16}$" wide with type X1558 CTC

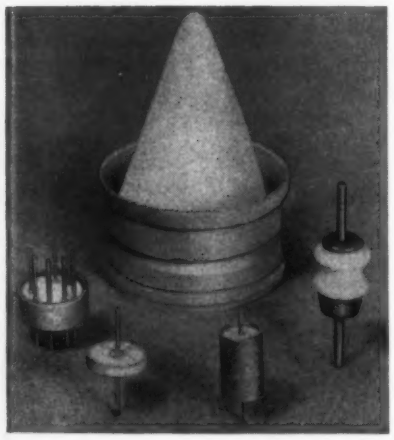


terminals, plus two 4-40 threaded grounding terminals at each end that also serve for mounting.—*Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.*

For more information circle **333** on inquiry card.

CERAMIC-TO-METAL HERMETIC SEAL

New metalized ceramics, glass, and hermetic seals designed to operate under high temperature conditions,

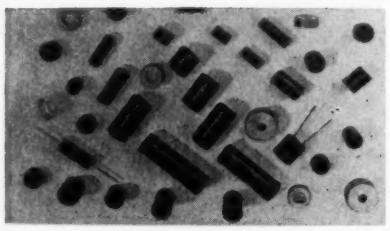


are manufactured and tested to insure conformity to the customer's specifications. Operating temperature limitation of the seal is governed solely by the type of brazing material specified, and the type of metal and ceramic used.—*Ceramatronics Inc.*, 364 *Highland Ave., Passaic, N. J.*

For more information circle **334** on inquiry card.

EPOXY E-FORM PELLETS

New E-Form pellet is a stable, dry blend of epoxy resin and hardener combined into an easily handled preform. Size and shape of pellet can be varied to serve as a metered charge for Epoxy E-Case shells. Pellet and electronic component are inserted into E-Case, then heated, causing the pellet to liquefy and flow around the



component. Further heating gels and cures the epoxy. The result is a completely epoxy-encased unit, resistant to humidity, temperature variations and corrosive influences. E-Form pellets can be automatically fed, positioned and assembled with the use of standard available machinery. —*Epoxy Products Inc.*, 137 *Coit St., Irvington, N. J.*

For more information circle **335** on inquiry card.

PC SOLDER AIDS

New miniaturized soldering aids for printed circuits have forked ends to disconnect soldered joints and spade end which reams solder from lug hole. Other uses include probing, scraping

and cleaning, positioning wires, lugs, contacts, parts. Tips are tempered to withstand heat and plated to shed solder.—*CBS-Hytron*, 100 *Endicott St., Danvers, Mass.*

For more information circle **336** on inquiry card.

RELAY SOCKETS

New socket for "Diamond H" Series W general purpose relays enables wiring of complete chassis or assembly before plugging in relays, also

socket leads may be connected to a panel or terminal board for easy rearrangement.—*The Hart Mfg. Co.*, 110 *Bartholomew Ave., Hartford, Conn.*

For more information circle **337** on inquiry card.

SUBMIN TOROID WINDER

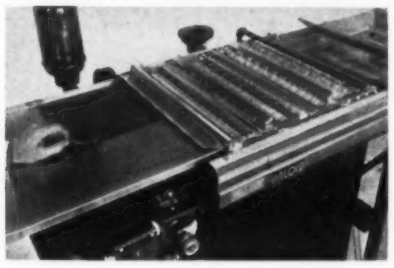
New model D is said to wind miniature and sub-miniature toroids with precision, uniformity, operational simplicity and versatility. Winds 300 turns of #29 H.F. wire on cherrio

core producing finished O.D. of 0.622" and I. D. of 0.125", by drawing the wire from the inside of patented shuttle. Wire sizes from #26 through #40 may be used.—*Electro Devices Inc.*, 580 *Main St., Wilmington, Mass.*

For more information circle **338** on inquiry card.

FILM PROCESSOR

New device automatically develops, fixes, and washes lithographic-size, cut-sheet film and negative papers. Will accept film or paper from 6" x 8" to 20" x 25". Processor holds 18-



gallons of developer constantly replenished by gravity feed from a 3-quart bottle. All metal parts are stainless steel, feed mechanism has saran belts and nylon pulleys and gears.—*The Haloid Co., Rochester 3, N. Y.*

For more information circle **339** on inquiry card.

AERIAL PANORAMIC EYE

New model 501 lightweight tracking camera for diverse applications in military operations, geological survey work, course monitoring for navigational training, aircraft altitude and velocity studies, highway engineering and other fields requiring extremely wide-angle continuous aerial photographic coverage of terrain. Rapid-scanning is used to obtain successive photographs covering 180° from horizon to horizon across a plane's line of

flight, with true velocity compensation throughout the scan. Has automatic sequencing with sufficient film capacity for a complete mission and can be set for either adjacent or stereo-overlapping pictures. Operation can be automatic or manual and can be started and stopped by remote control.—*Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **340** on inquiry card.

VISUAL TRACKING AID

New photoflash lamp assembly for drones or missiles may be remotely located weighs four pounds and is available for 28, 14, or 7-volt DC systems.

E 3046

PORTABLE POTENTIOMETER FOR THERMOCOUPLES

Rugged Metal Case, Small, Light Weight

Single or Double Range in Degrees F. or C., or M.V.

Binding Posts for Two Couples with switch for Selecting either. Automatic Cold Junction Compensation "15 Inch, Easily Read Scale."

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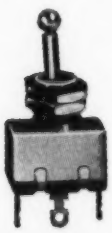
For more information circle **20** on inquiry card.

ALLIED'S NEW Subminiature TOGGLE SWITCHES



ACTUAL SIZE

These new subminiature switches are particularly well suited to printed circuit, transistorized and other miniaturized equipment.

SPECIFICATIONS:

Handle: Ball Type Toggle
Bushing: ¼-40 Thd.
Body: Single Pole—.520 x .270 x .320; Double Pole—.520 x .520 x .320
Terminals: Gold Flashed

Contact Ratings: Low level to 5 Amp. (Res.) 115 VAC, 24 VDC
Dielectric: 1000 volts RMS
Vibration: 10-G 10-500 cps
Shock: Specification MIL-S-901 (Type C)
Endurance: 10,000 Make and Break Cycles
Tumbling: In accordance with Signal Corps Requirements
Corrosion Resistance: 50 hour Salt Spray per Federal Spec. QQ-M-151
Humidity: 10 Cycles per Specification MIL-S-3950
Seal: Low Temperature Rubber Boot for Panel Sealing is available

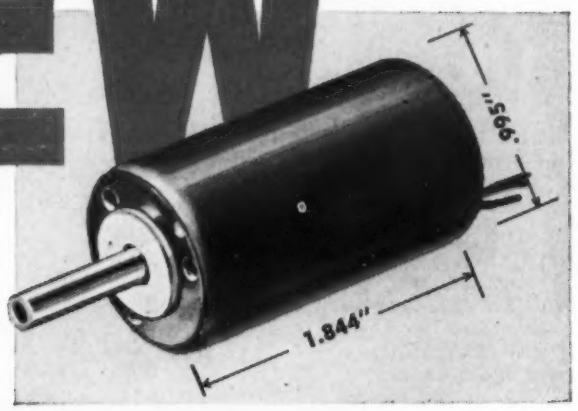
WRITE FOR BULLETIN TG

ALLIED CONTROL
MINIATURE SWITCH DIVISION OF
ALLIED CONTROL COMPANY, INC.,
2 East End Avenue, New York 21, N.Y.

AL 183

For more information circle **21** on inquiry card.

NEW



EAD's 1" MOTOR

Operates *Directly* Off the 115 volt, 60 cycle Line!

...no step-down transformers, no dropping resistors necessary!

NOW—for the first time, a miniature, precision motor that operates from a 115 volt, 60 cycle line—*directly!* And this new EAD unit offers higher performance and higher capacities than other 1-inch diameter motors.

Typical stall torque is 0.7 ounce-inches—no problem starting in cold temperatures—with a running torque of 0.4 ounce-inches. Packed with power and precision, EAD's motor gets *more* air from bigger fans! For example, it easily drives a 3" fan blade at 3200 rpm. It drives a 4" fan blade at 2700 rpm with only 6 watts input.

Whatever the application, as a fan or blower drive or general purpose induction drive motor, if you want high-output, longer life, a precision, power-packed miniature to do a dependable job, your answer is this new EAD 1-inch motor. It has *much more* to offer in your vital applications.

TYPICAL SPEED-TORQUE CHARACTERISTICS	
SPEED RPM	TORQUE OUNCE-INCH
3500	0
2900	.50
2500	.75
2000	.95
0	.74

Precision, Performance, Price—

Get All 3 at EAD!

WRITE FOR MORE INFORMATION TODAY!

EAD Eastern Air Devices, inc.

345 Central Ave., Dover, New Hampshire

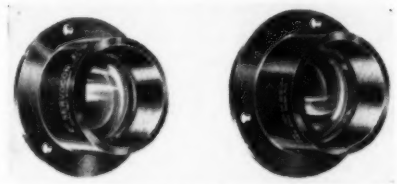
For more information circle **22** on inquiry card.

High-intensity flash lamp is housed in a reflector assembly which directs the light in a 120° cone. Flashing rate is 2 to 3 times per second with a 7-watt-second output per flash. Power requirement is 50 watts at 28 volts. Ambient temperature range is −55° to +130°F. at altitudes up to 55,000 ft.—*Research, Inc.*, 115 *N. Buchanan Ave., Hopkins, Minn.*

For more information circle **341** on inquiry card.

INFRARED ACHROMATIC LENS

New Servocon Lens for use in new infrared transmitting optical systems, has high speed and minimum spherical and chromatic aberration. Optimum

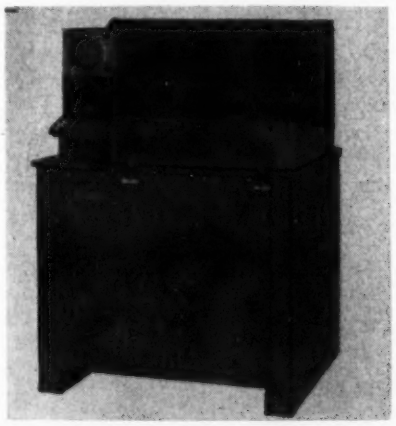


results are obtained when imaging distant objects radiating between 2 and 5 microns with good transmission from 1 to 6 microns. Servocon shown has focal length of 2", relative aperture of f/1.2. Other sizes and characteristics available.—*Servo Corp. of America*, 2020 *Jericho Tpk., New Hyde Park, N. Y.*

For more information circle **342** on inquiry card.

IMPULSE TEST STAND

New Model SX-89 tests hydraulic elements under simulated conditions of pressure and temperature up to 10,000 psi through impulse range of 0 to 100 cpm. Solenoid valves produce a

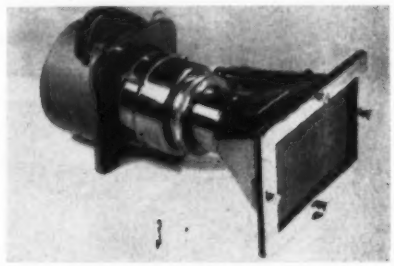


surge shock condition in the element on test which is displayed as waveform on CRO. Pressure is stabilized using nitrogen-charged hydraulic accumulator.—*Sun Electric Corp., Harlem and Avondale, Chicago* 31, *Ill.*

For more information circle **343** on inquiry card.

HI-VOLUME AIR SAMPLER

Used to detect and measure airborne radioactive particles, dust, smoke and smog for research and testing, the Air Sampler inhales an atmospheric volume measuring pollutants by means of deposits on filter papers. Integral fans operate from

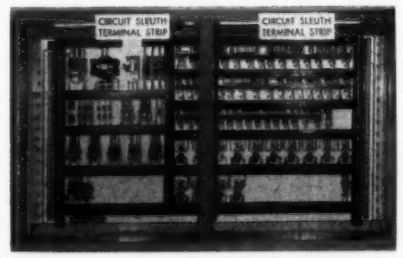


110vac or dc, 220vac or dc or 24vdc. Filter holder consists of mounting collar extended to a rectangular opening which accommodates 6" x 9" and 8" x 10" filter papers.—*The Staplex Co., Air Sampler Div., 777 Fifth Ave. Brooklyn* 32, *N. Y.*

For more information circle **344** on inquiry card.

CONTROL PANEL TROUBLESHOOTING

New circuit sleuth system for trouble shooting of complicated electrical control panels on automated machine tools consists of terminal strips in the control panel, to which all internal component connections are wired, and special pilot lights in the machine control panel. After a machine stops the maintenance electrician looks at the light panel to determine from "lights out" the machine location and operation where the



trouble exists. Overall circuit and electrical component checks of the system are made by checking with test set the numbered terminals on the circuit sleuth strip. The system is optionally available on all Snyder machine tools with automation.—*Snyder Tool and Engineering Co.*, 3400 *E. Lafayette, Detroit* 7, *Mich.*

For more information circle **345** on inquiry card.

GOLD ALLOY POT WIRE

New Secon alloy #443, for precision potentiometer wire, characteristics are specific resistance 80 ohms/circular mil foot, temperature coefficient of resistance (0° −100°C) .0006, and tensile strength (PSI x 1000) 160.0.—*Secon Metals Corp., 7 Intervale St., White Plains, N. Y.*

For more information circle **346** on inquiry card.

COMPUTER KIT

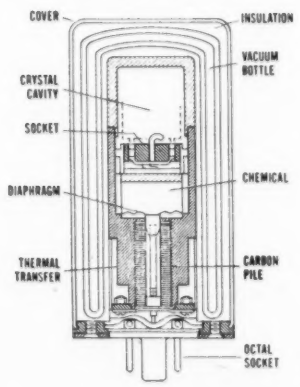
New "do-it-yourself" FF-3 computer kit includes special mounting chassis capable of holding 15 plug-in

transistorized printed circuit digital system elements or "cards." Fourteen different configurations are available for combination to meet a wide variety of computer and control applications.—*Comptron Corp., Belmont* 79, *Mass.*

For more information circle **347** on inquiry card.

CRYSTAL OVEN

New crystal oven uses the latent heat of fusion of crystalline matter to provide constant crystal cavity temperatures, and a chemical thermostat, with proportional heat control in lieu of the conventional bimetallic type. Contact noise, power surges, random variations of oven temperature and cavity temperature drift are said to be eliminated. At 24°C ambient, cavity temperature is 70.6°C. Temperature

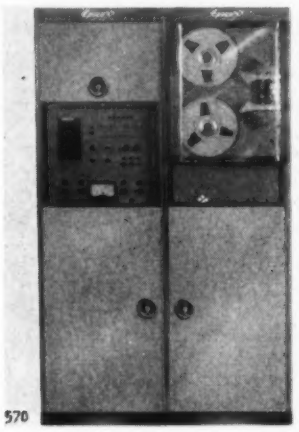


control is within ±0.5°C from −20°C to +50°C ambient and approximately ±0.005°C at fixed ambient. 12 ounce, 2" x 4" oven has temperature control of a crystal or crystal oscillator for secondary frequency standards and constant temperature maintenance. Heater voltage: 5 volt a.c. or d.c. regulated ±2%; heat power under control: 1.6 w at TA 24°C, 3.5 w at TA −20°C.—*Robertshaw-Fulton Controls Co., Aeronautical Div.,* 401 *N. Manchester, Anaheim, Calif.*

For more information circle **348** on inquiry card.

MAG-TAPE SYSTEM

New Model DR-704/711 Compu-Corder prepares digital test data on magnetic tape in exact computer format; gathers asynchronous digital in-



formation from several external sources and combines them in any selected sequence together with record numbers and manually inserted fixed data. Not only can data sequence be arbitrarily selected, but tape format and gap length can also be varied.—*Epsco, Inc.,* 588 *Commonwealth Ave., Boston* 15, *Mass.*

For more information circle **349** on inquiry card.

TARGET ACQUISITION COMPUTER

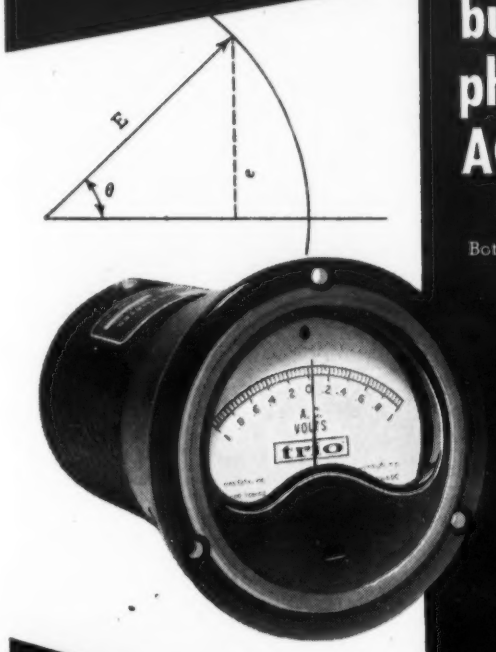
New Model 8-1101 coordinate converter is high-precision special purpose analog computer which accepts d-c voltages representing X, Y, and Z coordinates and automatically performs transformation to azimuth angle, elevation angle, and slant

range. Geographic range is also available as output signal. The computer includes ten computing amplifiers and four servo resolvers.—*Dynalysis Dev. Labs., Inc.,* 11941 *Wilshire Blvd., Los Angeles* 25, *Calif.*

For more information circle **330** on inquiry card.

new from trio...

build-in miniature phase-sensitive AC VTVMs



for *building into* military & industrial test & operating equipment. Both single- and multi-range zero-center models indicate Vcosθ — the product of signal magnitude & cosine of phase angle between signal & reference voltages. No controls or operating adjustments. When signal & reference are in phase, meter deflects to right; when out of phase, to left. Ideal for AC null readings. Perfect quadrature rejector as long as signal magnitude does not exceed full scale. Wide variety of standard packages. Sensitivities of single-range models from 10 MV; multi-range, as low as 1 MV.

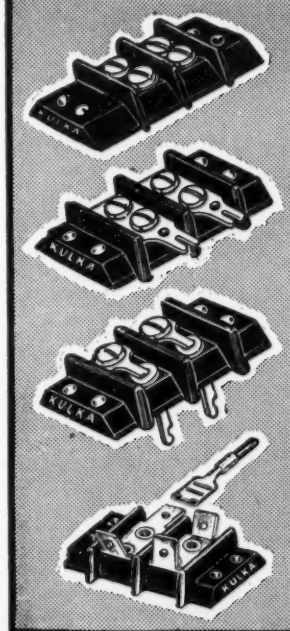
For free 36-page Engineering Guide, write to Dept. **MA-11**
Trio Laboratories., Seaford, N. Y.

when ordinary instruments are too big or inadequate . . .

trio

For more information circle **23** on inquiry card.

KULKA ELECTRICAL WIRING DEVICES
Designed For Performance and Economy



TERMINAL BLOCKS (Left): Large line of molded, barrier type, in varied sizes, materials, and terminals. New "KLIPTITE" style (left bottom) with angled tabs made for AMP, self-locking wire terminals.

TOGGLE SWITCHES (Below): Aircraft type, Single and Double Pole. Bakelite housing. Screw terminals or soldering lugs. One-hole mounting. DC, or AC up to 1600 cycles.

POWER OUTLETS (Below, right): Smallest made for standard plug. Mounts from top or bottom of bracket. Soldering terminals or wire leads.

Catalog No. 14 **Sent On Request**

KULKA ELECTRIC MFG. CO., Inc.
633-643 SO. FULTON AVE. MOUNT VERNON, N. Y.

For more information circle **24** on inquiry card.

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for any PURPOSE

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DuKane's dependable commercial electronic products are serving industry, schools, hospitals and offices across the nation! Details upon request!

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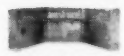


Industrial and School Sound Systems

Micromatic Sound Slidefilm Projector

Private Telephone Systems

For information on DuKane's capabilities, write
DuKane Corporation, Dept. E-12
St. Charles, Illinois

Name_____

Address_____

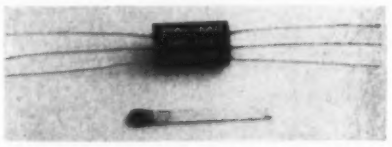
City_____ State_____

Firm_____

For more information circle **25** on inquiry card.

PULSE TRANSFORMERS

New Stat-Tran pulse transformers for transistor blocking oscillator circuits use high permeability ferrite core (2400μ) to achieve low leakage inductance and good impedance match

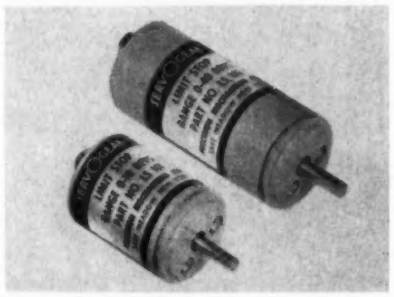


to transistor, permitting operation to rep rates of 500 kc. Low impedance output pulses essentially equal to the supply voltage can be varied from 0.2 to 40μ sec.—*Pulse Engineering, 2657 Spring St, Redwood City, Calif.*

For more information circle **351** on inquiry card.

MINI MULTITURN STOP

New adjustable stop is available in two models, 0-10 revolutions and 0-40 revolutions, for servo, instrument, and precision mechanisms. It features a single range-setting screw, available at the end cap, capable of adjusting stop rotation from zero to

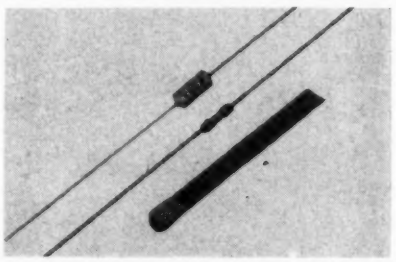


full scale continuously; torque capacity of 40 ounce inches, precision ball bearings, and construction of corrosion resistant steel and anodized aluminum conforming with MIL-E-5400.—*Precision Mechanisms Corp., 577 Newbridge Ave., East Meadow, N. Y.*

For more information circle **352** on inquiry card.

CARBON FILM RESISTORS

New type C-1H is sealed in a ceramic case for protection against humidity and damage. Meets specs MIL-R-10509B, Characteristic "B", Type C1, resin coated is not damaged

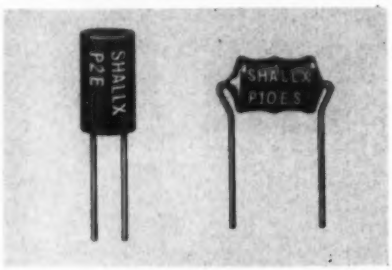


when potted in epoxy resing. Meets specs MIL-R-10509B, Characteristic "X". Resistance range 5 to 100,000 ohms, wattage 1/10 watt at 70° C.—*Mepco, Inc., Morristown, N. J.*

For more information circle **353** on inquiry card.

PRECISION WIREBOUND RESISTORS

New miniature non-inductive precision wirewound resistors for printed circuits are sealed in epoxy resin for ambients up to 125°C. P2 type 27/64" x 13/64", in values to 200,000 ohms has tolerance to 0.1% with

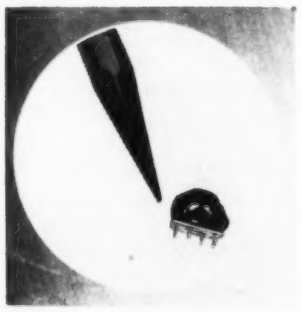


power rating for 1% tolerance at 0.3w. Type P10S has resistances to 1 meg, tolerances to 0.1% and power rating for 1% tolerance of 0.5w.—*Shallcross Mfg. Co., Collingdale, Penna.*

For more information circle **354** on inquiry card.

PC PLUG-IN TRANSFORMER

New epoxy encapsulated units for printed circuits, moisture and high temperature resistant have plug-in

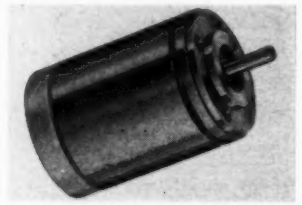


terminals spaced on multiples of 0.1" for standard grids. Developed for printed circuits, thin gauge alloys and latest winding techniques are used.—*Celco Constantine Engineering Lab. Co., Island Ave., Mahwah 1, N. J.*

For more information circle **355** on inquiry card.

SERVOMOTOR

New model 11 SM 460, 115v 400 cycle, high torque to inertia servomotor is rated for 200°C unit temperature continuous duty operation at stall. Rotor inertia of 1.07 gm. cm.^{2} and acceleration at stall of 41,500 radians/sec^2 requires 4w/phase and



insures fast precise response to error signals. Unit is 1.632" long, 1" dia., and weighs 4 oz.—*Beckman/Helipot Corp., Newport Beach, Calif.*

For more information circle **356** on inquiry card.

are you LOOKING for fine pitch precision gears?

If your requirements include 1/8" to 5" O.D.—180-16 D.P. AGMA Precision #3 Then, write us for prompt response, today!

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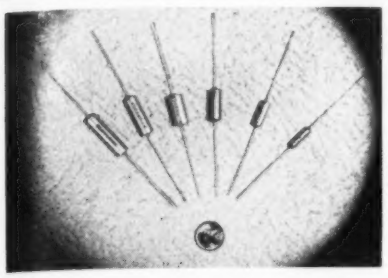
HOB

For more information circle **26** on inquiry card.

MINIATURE ELECTROLYTIC CAPACITORS

Ratings range from 1 to 125 microfarad and 4 to 150v dc. Operating temperature range is −20C to +85C, lengths range from ⅝" to 1¼" and diameters from 3.16" to $\frac{5}{16}$". Centered

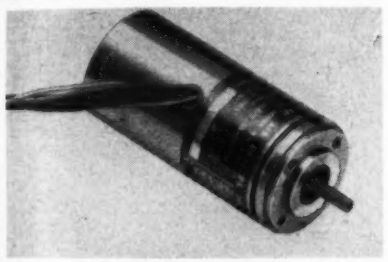


axial leads permit automatic insertion in printed circuit boards. The case is electrically insulated, sealed with epoxy casting resin.—*The Magnavox Co.*, 2131 *Bueter Rd., Fort Wayne, Ind.*

For more information circle **357** on inquiry card.

TACHOMETER

New short version, size 11, motor tachometer, now 2.125" long, also has improved electrical characteristics.

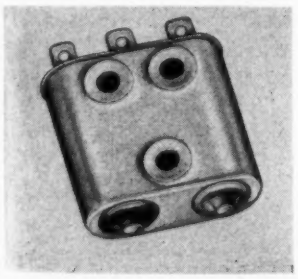


This 115v tachometer delivers 0.6v per 1000 rpm with 19 millivolts of total null, and meets Bu Ord Mk 14 specs. Upper temperature rating is 150°C.—*Eastern Air Devices Inc.*, 385 *Central Ave., Dover N. H.*

For more information circle **358** on inquiry card.

PRESSURE SWITCH

New hermetically sealed switch has a balancing system which automatically equalizes environmental pressures so that the actuation force remains the same regardless of surrounding pressure or vacuum. De-

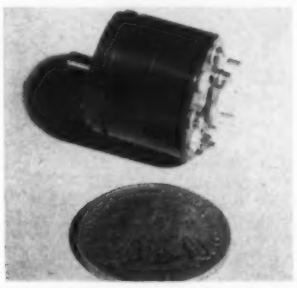


signed for refrigeration, missiles and rockets, aircraft, petroleum refining and other broad fields of chemical processing—*Haydon Switch Inc., Waterbury* 20, *Conn.*

For more information circle **359** on inquiry card.

MICROSYN

New units have a sensitivity of 500 millivolts per degree with a threshold of 0.01 degree at 20v excitation. Linearity is within 0.5% to seven degrees;

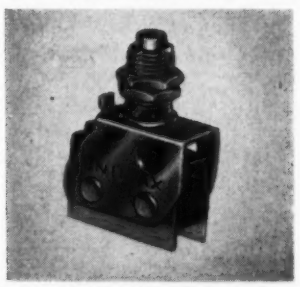


weighs less than 1.2 ozs. Units may be used in position-indication of gyros, control follow-up devices, computation, process control, motion and torque amplification. Excitation may be 20v, 400 cps or 25 v, 800 cps.—*Lear Inc.*, 110 *Ionia Ave., NW, Grand Rapids* 2, *Mich.*

For more information circle **360** on inquiry card.

SUB-MINIATURE SWITCH

New type USM3J-1 is designed for high temperature applications up to 275°F. The type USM5J-1 is designed

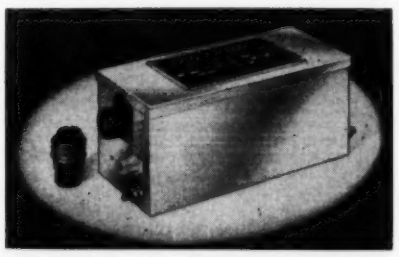


to meet Mil Specs Mil-S-6743. Electrical ratings are 2½ amps 30v dc, inductive; 4 amps 30v dc, resistive; 5 amps 125/250v ac.—*Unimax Switch Div., The W. L. Maxson Corp., Ives Rd., Wallingford, Conn.*

For more information circle **361** on inquiry card.

LINE NETWORKS

New series FSR-700 line impedance stabilization networks meet Mil. specs. requiring insertion of network in each power supply and electrical load lead during measurements of radiated and



conducted noise. Available for 50 to 500 amp service with voltage ratings to 115v at 800 cps, 230v at 400 cps, 440v at 60 cps and 600v for dc operation.—*Filtron Co. Inc., Flushing, N. Y.*

For more information circle **352** on inquiry card.

Low Cost!
High Efficiency!

UAC Transistorized Mobile Power Supplies

- for Transceivers
- for Receivers
- for Railroad Applications

Compact, lightweight units specifically designed to convert battery voltage DC to high voltage DC in two-way radios, public address amplifiers, or wherever conventional power supplies are used. UAC units are rugged, vibration-resistant converters that outlast vibrator power supplies by thousands of hours. No moving parts . . . No wear . . . No tear . . . No arching.

SPECIFICATIONS

TRANSCEIVER SUPPLY	RECEIVER SUPPLY
INPUT: 12 VDC*	12 VDC or 13.6 VDC*
OUTPUTS: 450 VDC @ 255 MA; 275 VDC @ 150 MA; −55 VDC @ 5 MA	250 VDC @ 130 MA or 290 VDC @ 130 MA
TEMPERATURE RANGE: −55°C to +71°C	−55°C to +71°C
EFFICIENCY: 85%	85%
SIZE: 3½"x5"x3"	2¾"x2¾"x2¾"
WEIGHT: 3½ lbs.	8 oz.
LIST PRICE: $85	$45

*For Railroad Applications:
Same Specifications with 64 to 72 VDC Input at additional cost.

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For more information circle **27** on inquiry card.

NOW! Accurate Functional Tests of Complex Relay Systems!

DIT-MCO Model 250F FUNCTIONAL TESTER

The Model 250F can automatically test the functional components and associated wiring of any complex relay system! The Functional Tester makes conclusive tests for continuity, continuity-discontinuity, discontinuity-continuity, insulation-resistance and shorts in relay systems involving switches, solenoids, actuators, resistors, etc. Features a timer for checking time-delay circuits and plugboard programming which permits efficient test planning and make-ready. Operation is easily mastered by non-technical personnel.

plus **These features of DIT-MCO's famous CIRCUIT ANALYZER!**

- **ELECTRONIC DETECTOR UNIT** . . . automatically tests quality to pre-set values!
- **TESTS UP TO 200 CIRCUITS** . . . in less than a minute!
- **MATRIX CHART** . . . pinpoints location and type of error automatically!
- **VACUUM-TUBE OHMMETER** . . . allows any circuit to be measured at any time during test!
- **UNIVERSAL** . . . adaptable to any relay system without modification!
- **STANDARD PARTS** . . . trouble free operation from telephone-type parts!

For additional information on the Model 250F or DIT-MCO Circuit Analyzers write: Box 12-27,

DIT-MCO, INC.

ELECTRONICS DIVISION

Box 12-27, 911 Broadway
Kansas City, Missouri

For more information circle **28** on inquiry card.

MAGNETIC BRAKE

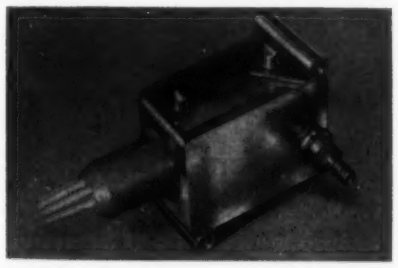
New Model 1041 has built-in damper. When the magnetic brake is energized, input shaft is unlocked and eddy current damper resists input forces in direct proportion to input speeds.

When electrically deenergized input shaft is locked to resist torque up to 200 inch-pounds. For aircraft use, weighs 1.25 lbs., measures 4.10"x1.85" x3.00".—*Lyndon Aircraft, Inc.*, 140-61 *Clifford St., Newark, N. J.*

For more information circle **363** on inquiry card.

ROTARY SWITCH

New precision MS24456-Type basic switch, for use in aircraft landing gear and engine controls, missile launchers, and radar and industrial equipment, has a capacity of 10 amps, resistive, 30 vdc, 115 vac. New switch

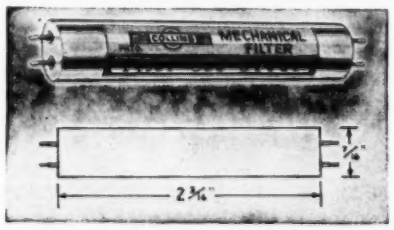


is said to feature excellent shock and vibration resistance, operation in ambient temperatures from −65°F to +275°F. and heavy nickelplated steel case for increased protection.—*Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.*

For more information circle **364** on inquiry card.

MINIATURE FILTERS

New Y Series miniaturized mechanical filter, hermetically sealed in a metal tube 2-$\frac{3}{16}$" L by $\frac{7}{16}$" D, represents a substantial size reduction



is said to be ideal for printed circuits. Models are available in center frequencies of 455 kc with 6 db, bandwidths of 2.1, 3.1, 4.0, 6.0, 8.0, 12.0, 16.0, and 35.0 kc.—*Communication Accessories Co., Lee's Summit, Mo.*

For more information circle **365** on inquiry card.

CERAMIC RELAY

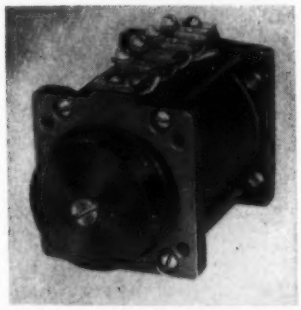
New type for missile applications operates during vibration of 25g from 10 to 2000 cps, 50g shock, and at 200°C without contact chatter. Uses three contacts in parallel in each switching circuit to achieve reliability, high-current capacity and elimination of contact bounce. Will switch

low level "dry" circuits in the mv-μa range and handle inductive loads with peak inrush currents of 60 amp. Continuous rating of the contacts is 25 amps at 300v. Type RA1 is SPDT, type RA4 is a 4-PDT relay.—*Jennings Radio Mfg., Corp., P. O. Box* 1278, *San Jose, Calif.*

For more information circle **366** on inquiry card.

SERVO DAMPERS

New viscous-coupled model CD-60 dampers are said to solve servo stability problems without tachometers or networks. High velocity and torque constants are obtainable by simple stabilization techniques. Mount

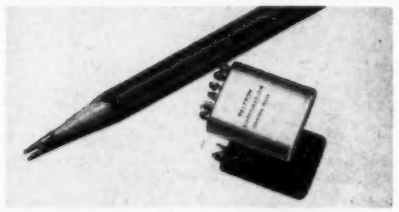


directly on Hiehl FPE-25 5-watt servomotors. Time constants factory adjusted to meet customer's specification.—*Feedback Controls Inc.*, 899 *Main St., Waltham* 54, *Mass.*

For more information circle **367** on inquiry card.

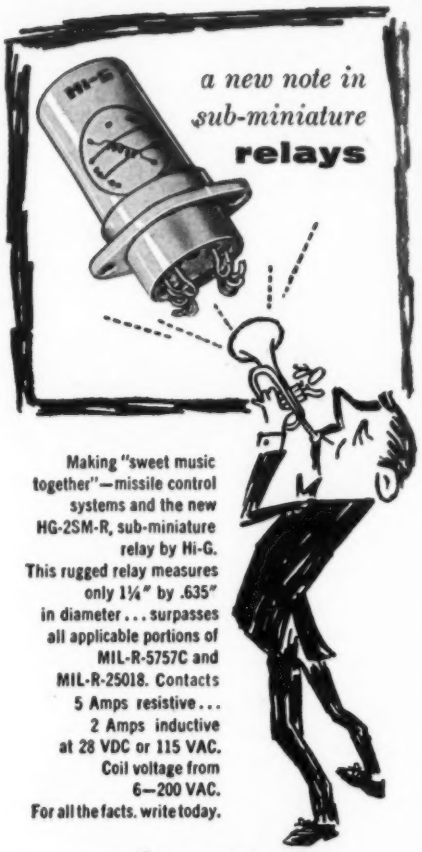
SUB-MINIATURE RELAY

New Type 47 relay will provide continuous duty to 200°C and intermittent duty to 250°C. Is hermetically isolated from contact assembly to insure contamination free contacts, and



to permit use of new insulation techniques. Will withstand extremes of shock and vibration; weight 0.5 oz.—*Reltron Corp.*, 282 *Centre St., Newton* 58, *Mass.*

For more information circle **368** on inquiry card.



Making "sweet music together"—missile control systems and the new HG-2SM-R, sub-miniature relay by Hi-G. This rugged relay measures only 1¼" by .635" in diameter . . . surpasses all applicable portions of MIL-R-5757C and MIL-R-25018. Contacts 5 Amps resistive . . . 2 Amps inductive at 28 VDC or 115 VAC. Coil voltage from 6—200 VAC. For all the facts, write today.

another outstanding

Hi-G relay

HG-E2

Sub-miniature . . . hermetically sealed . . . space saving, this HG-E2 relay measures 1" square by 31/32" . . . meets MIL-R-5757C. Designed for operating temperatures up to 125°C. with long-life characteristics at rated contact loads of 2 amps at 28 Vdc or 115 Vac. Coil resistance ranges of 50 to 10,000 ohms. Hook terminals or straight pins for plug-in and printed circuit applications are standard. Available in Form A, B, or C contact arrangement with maximum of two poles . . . for AC operation with internally mounted silicone rectifiers.

Today . . . find out more about the complete line of Hi-G sub-miniature relays.

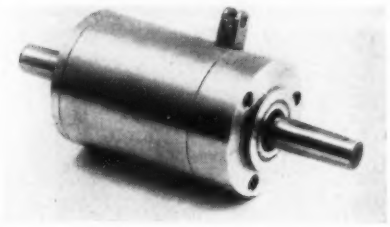
Hi-G inc.

BRADLEY FIELD • WINDSOR LOCKS, CONN.

For more information circle **29** on inquiry card.

MAGNETIC AMPLIFIER

New model A-300 has an amplification of 200 X, whereby 10 inch-lbs of transmitted torque are controlled with an energizing torque of 0.05 inch-lbs, which corresponds to a force of 3 to 5 ounces at the control lever. The response time is only 0.001 sec and tests have been performed up to 6300

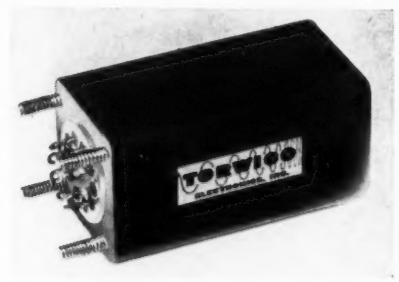


RPM. The entire clutch mechanism with the controls is compact being built into a cylindrical envelope of ⅞" diameter and 1 13/32" length. The clutch mechanism is supported by three ballbearings and the input and output shafts are coaxially aligned; the cylindrical envelope has provisions for flange or cleatmounting.—*Digitronics Corp., Albertson Ave., Albertson, L. I., N. Y.*

For more information circle **369** on inquiry card.

MINIATURE RELAY

New "Tinymag" unit combines magnetic amplifier and relay to operate on 25-microwatt unfiltered dc signals directly from thermocouple, resistance bridge, photocell, synchro, or radio receiver detector. Absence



of "chatter" allows operation at full sensitivity in a 40 G shock, 20 G vibration environment. Excitation is 26 v at 400 cycles, power consumption a few milliwatts. Operating range is from −55 to +100°C.—*Torwico Electronics Inc.*, 1090 *Morris Ave., Union, N. J.*

For more information circle **370** on inquiry card.

SUBMIN RELAYS

New subminiatures designed for mass production retain same basic design as custom-designed relays, differencies in application are enabled by a variety of modifications. Approved for use in all military aircraft, relays are hermetically sealed.—*Phillips Control Corp., Joliet, Ill.*

For more information circle **371** on inquiry card.

SERVO REPEATER

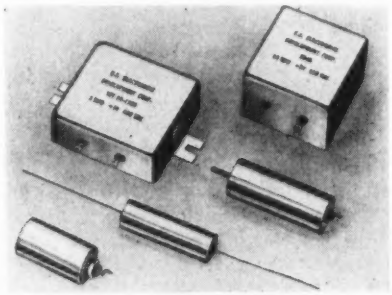
New model W1801 repeater system includes a transistor servo amplifier, motor, synchro, power supply and gear train, all in 2" in dia., 4" long housing. Power requirements are 10 watts, 400 cps at either 115 v or 26 v.

Weight 12 oz. With a gear ratio of 210 to 1 between motor and output shaft, unit develops shaft position output exceeding 20 oz. in. at velocity constant of 60 sec.$^{-1}$. Static accuracy is within 0.1° of input from external synchro or transducer. Can be modified to meet specific applications. All components meet Mil Specs.—*Waldorf Instrument Co., Wolf Hill Rd., Dix Hills, Huntington Station, N. Y.*

For more information circle **372** on inquiry card.

CAPACITORS

New Mylar capacitors with compression type glass-to-metal hermetic seals are available in either non-inductive extended foil or inductive tab

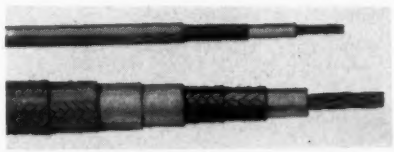


models. Multiple-layer Mylar capacitors have an operating temperature range of −65° to +125°C with a dissipation factor not exceeding 0.5% at 1000 cps.—*U. S. Electronics Development Corp.*, 1323 *Airway, Glendale 1, Calif.*

For more information circle **373** on inquiry card.

COAX CABLES

New RF and miniaturized RF Coaxial All Teflon Cables meeting Mil-C-17B specs. and operating to 200°C, in standard sizes of RG/U 187



through RG/U 196 are available in 50, 75, and 95 ohms impedance. Construction is silver plated copper shield.—*Times Wire & Cable Co., Inc., Wallingford, Conn.*

For more information circle **374** on inquiry card.

New CPI

PLUG-STAT®

TWO WIRE HERMETICALLY-SEALED

- NO DRIFT
- RUGGED
- CLEAN MAKE AND BREAK

Extreme shock, vibration and other severe environmental conditions will not affect the precise thermal indication of this new CPI hermetically-sealed thermal sensing switch. The new Plug-Stat® is a two-wire, rugged unit with stainless steel welded body and special alloy contacts that make and break *fast* and *clean* at set limits *without drift of calibration.*

This new Plug-Stat® operates accurately in environmental temperatures from minus 65°F. to plus 700°F. and is capable of a 200°F. overshoot from the specified operating temperature. Calibration temperature range from minus 20°F. to plus 700°F. is factory set to a specified tolerance and sealed.

Where you require an extremely sensitive response to high or low temperatures, this new non-drift thermal switch will fit your needs.

Ask about the SINGLE-WIRE PLUG-STAT,® *too*

Another in the CPI family of thermal switches is this single-wire Plug-Stat® for applications where required temperature range limits are minus 20°F. to plus 600°F.

Write now for complete engineering data.
Ask for Catalog MA.

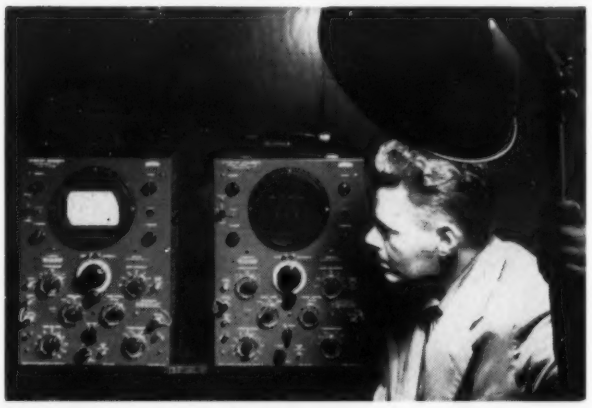
Control products, inc.

665 HARRISON, N.J.

For more information circle **30** on inquiry card.

Black-Background CRT

Tubes available for converting radars and test scopes already in the field to viewing in highly illuminated areas have been developed by Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J. Limitations of radar and other visual electronic indicators due to surrounding high light-level conditions are

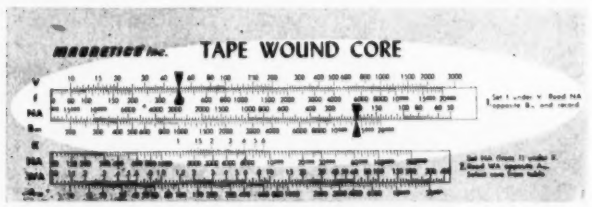


eliminated by the development of a special black background screen which creates the same high contrast characteristics that might be attained with a "black phosphor." Actual techniques are not disclosed. Hoods and bothersome surrounding light adjustments for viewing oscilloscopes etc. are not necessary. High degree of uniformity and contrast characteristic of the screen make it ideal for precision radar and oscilloscope photography.

For more information on Black Background CRT's circle **210** on inquiry card.

Tape Wound Core Calculator

New slide rule provides calculation of magnetic design problems relating voltage to flux, current to magnetizing force, and wire to space factor. Design of tape-wound core and winding to support 50 volts at 400 cps, and to carry 0.5 amps is one of the problems readily solved by following the "how to" instructions provided.



Select the frequency and voltage of the power source from which the core or amplifier is to operate. Locate these values on slide 1 and place f opposite V.

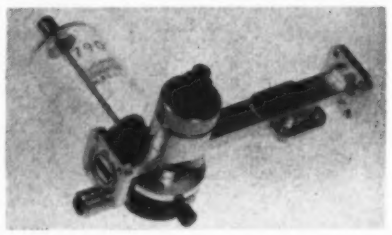
Select the maximum flux density at which the core is to operate. Typical values are:
Orthonol—14000 gausses • 48 Alloy—12000 gausses • Hy Mu 80—7000 gausses
Opposite this value of flux density on Slide 1, read the NA product required.

Basic Formulae, operating instructions, core table, wire table, and examples of operation are contained in instruction booklet accompanied by free slide rule. (*From 8-page instruction booklet, Magnetics Inc., Butler, Pa.*)

For this literature circle **104** on inquiry card.

16.5 KMC HIGH POWER ROTARY JOINT

New Ku-Band MA-651 rotary joint which permits relative rotation between two waveguide members, will handle RF peak powers close to the



max capability of RG-91/U waveguide, and can be pressurized up to 60 psig for increased handling capability. Frequency range 16.3 to 16.7 kmc/s, power rating (unpressurized) 60 kw. Pressure rating 60 psi gage. —*Microwave Associates, Inc., Burlington, Mass.*

For more information circle **375** on inquiry card.

VIDEO TERMINATION

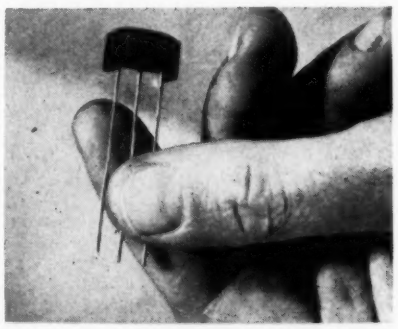
New type RF-300 coaxial termination has a turret type lug at the rear providing a connection point for an oscilloscope, less than two degree phase shift up to 250 mc., deposited

carbon resistor rated at ½" watt, accuracy 1%, and nominal resistance of 75 ohms. Housed in standard UHF type connectors. Length—2", dia.—¾".—*The Daven Co., Livingston, N. J.*

For more information circle **376** on inquiry card.

SELENIUM RECTIFIER

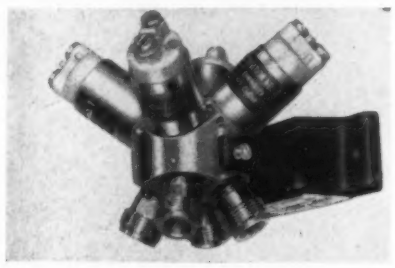
New model SE51K4D883 requires no filament supply, has long service life and withstands 80 ma current surges. Specs. are max. applied voltage 26v rms, max. output 20v dc, peak inv. voltage 40v.—*Bradley Labs. Inc., New Haven, Conn.*



For more information circle **377** on inquiry card.

TRANSFER COAXIAL SWITCH

New series 17,000 switch permits crossover and/or double-pole transfer switching of coaxial cable for frequencies up to 5000mc. Independent solenoids give complete control over make-before-break and break-before-

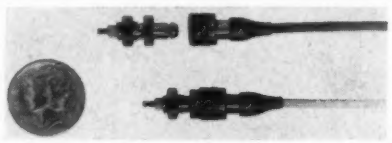


make. Designed to meet MIL-E-5272A, switch is 3" x 3½" x 2½", weighs 13 ozs with mounting bracket and is adaptable to various coil voltages from 28 to 120v dc.—*Transco Products Inc.*, 12210 *Nebraska Ave., Los Angeles, Calif.*

For more information circle **378** on inquiry card.

MICRO MINIATURE COAXIAL CONNECTORS

New snap-lock design for fast, easy connection in limited-access spaces and increased reliability is positive and withstands shock and vibration over long periods, without signal loss, loosening, or mechanical damage.

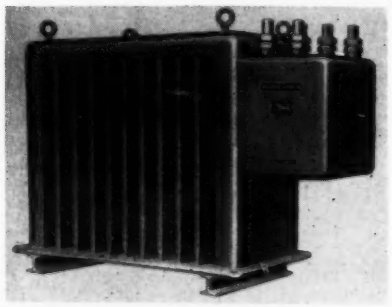


Units will take 100 G shocks in any axis. Frequency range is 0 to 12 kmc and impedance values are 50, 75 and 95 ohms. Temperature range is −70°F to +550°F. Will withstand vibration up to 10 G at 10-3000 cps, and all materials meet mil specs.—*Electro-Physics Labs.*, 2065 *Huntington Dr., San Marino, Calif.*

For more information circle **379** on inquiry card.

POWER SUPPLIES

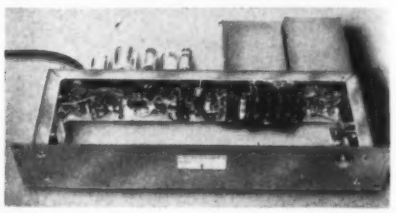
New oil filled silicon rectifier power supplies are available from 50 to 500 kw with inputs up to 4160 v, outputs to 250v dc. Approx. 95% efficiency and voltage regulation of 5% or better is claimed. Measures 90" x 72" x 44".—*Norma-Hoffman Bearings Corp., Walker Div., Hamilton Ave., Stamford, Conn.*



For more information circle **380** on inquiry card.

COMPUTER POWER SUPPLIES

New multi-output transistorized supplies in three types are; 115v60cps input for line operation, 115v400cps input for airborne applications, and 24 vdc input for portable instruments.

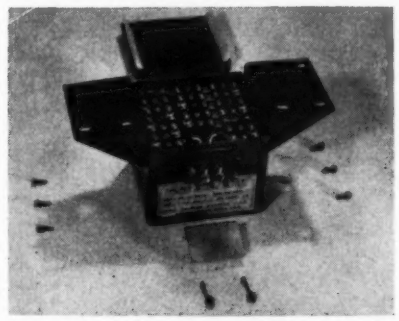


Typical line-operated unit has seven low impedance outputs ranging from +30 vdc at 2 amps to −30 vdc at 5 amps, fits standard relay rack and weighs 22 lbs.—*Universal Transistor Products Corp.*, 143 *E. 49th St., New York* 17, *N. Y.*

For more information circle **381** on inquiry card.

NICKEL CADMIUM STORAGE BATTERIES

New sintered plate nickel cadmium batteries using nylon cell containers operate from −60°F to +200°F and cycle life is virtually unlimited. Can



be stored for years in any state of charge without damage—charge retention is excellent. Have very high discharge rates, rapid charge acceptance, close voltage regulation during discharge, do not give off corrosive fumes and there is no gassing on discharge.—*Nickel Cadmium Battery Corp.*, 64 *Pleasant St., Easthampton, Mass.*

For more information circle **382** on inquiry card.

MICROWAVE SPECTRUM ANALYZER

New model SA30 analyzer features 30 X 5 direct-frequency reading X-band rf head, having 0.05% accuracy and other interchangeable precision heads from 800 to 40,000 mcs.—*Vectron Inc., Waltham* 54, *Mass.*

For more information circle **383** on inquiry card.

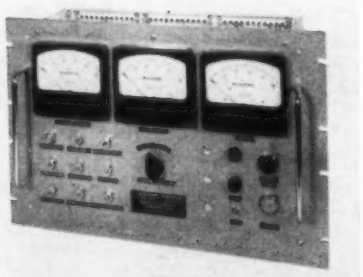
FM/FM INFO CAPACITY TEST

New Model TDC-5 for discriminator linearity measurements in 18 RDB subcarrier channels and 5 optional 30% channels, also converts phase distortion in the discriminator package into harmonic distortion for analysis on the screen of a Panoramic Analyzer. Five deviation frequencies for each channel may be set at whatever points desired: for example: +7.5%, +3.75%, −3.75%, −7.5%. Each frequency is crystal controlled to within ±0.02%. To check phase distortion a stepped FM wave is generated for each subcarrier discriminator. By adjusting the cycling rate of the TDC-5, continuously variable from 2 to 2,000 cps, until a clear picture is obtained on the Analyzer, the maximum information capacity of each channel may be established.—*Panoramic Radio Prod. Inc.*, 520 *S. Fulton Ave. Mount Vernon, N. Y.*

For more information circle **384** on inquiry card.

PULSE RATE COMPUTER

New transistorized nuclear reactor control instrumentation covers start-up, intermediate, and power ranges of operation. Various optional com-

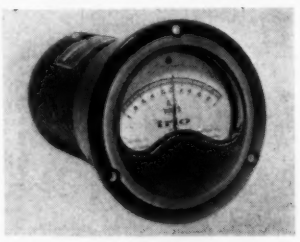


binations and modifications are available, providing flexibility to meet Mil specs for use aboard Naval vessels and in Army packaged power plants.—*Fairchild Camera & Inst. Corp., Robbins Lane, Syosset, N. Y.*

For more information circle **385** on inquiry card.

MINIATURE AC VTVM's

New phase-sensitive ac VTVM's in single and multi-range models for building into test and operating military equipments, provide indications equal to $V\cos\theta$ (θ being phase angle between signal and reference voltages). When signal and reference are in phase meter deflects right; when out of phase, it deflects left indicating both direction and magnitude of deviation.—*Trio Labs. Inc.*, 4025 *Merrick Rd. Seaford, N. Y.*



For more information circle **386** on inquiry card.

AUTOMATIC MICROMETER

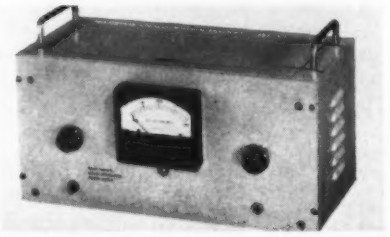
New model JDR read-out automatic electronic micrometer for precision measurement of fragile or compressible non-conducting materials eliminates all operator discrimination other than reading counter when contact with work is signalled. Counter has

large direct-reading numerals to 20 millionths of an inch over a range of of ½ inch and a throat depth of 2". Upper head is adjustable in height to accommodate work up to 1½ in. thick. Standard anvil is readily removed for use of special fixtures, repeatability is 0.00002 in. Micrometer is 14 in. high, 9 in. deep, 5½ in. wide. An optional foot switch can be used instead of lever switch.—*J. W. Dice Co., Englewood, N. J.*

For more information circle **387** on inquiry card.

MICROMIKE ELECTROMETER

New Model 565A for low currents in ion chambers and high-impedance networks is said to have accuracy better than 1% full scale; stability after first hour exceeding 1% per 24 hours;

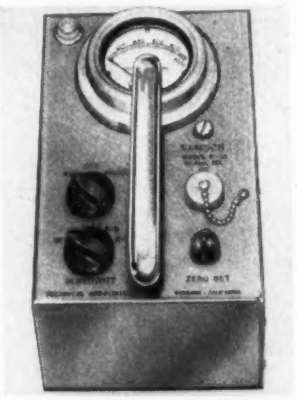


and linearity ±1% full scale. Five ranges of from 2.5 x 10^{-9} to 2.5 x 10^{-13} amperes, with maximum full-scale current sensitivity of 2.5 x 10^{-13} amp. Conforms to ORNL Spec Q826B, operates on 115 V, 60-cycles.—*The Victoreen Instrument Co.*, 5806 *Hough Ave., Cleveland* 3, *Ohio.*

For more information circle **388** on inquiry card.

SURVEY METER

New Model S-12 alpha survey meter, is calibrated directly in disintegrations per minute. Will detect alpha



particles with energies as low as 1 mev. or beta radiations with energies as low as 15 kev. for checking contamination of benches, floors, and walls.—*Technical Assoc.*, 140 *W. Providencia Ave., Burbank, Calif.*

For more information circle **389** on inquiry card.

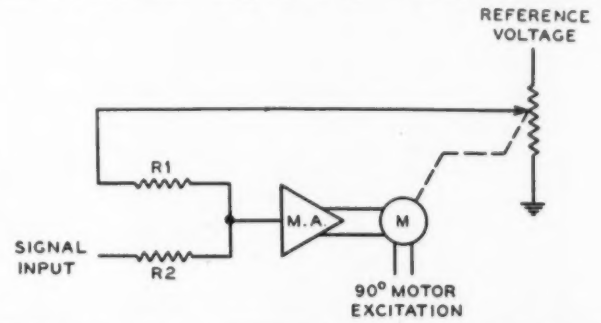
HIGH-TEMPERATURE WIRE

New method for insulating high-temperature miniature wire and cable is known by the trade name of FLEX-OLON, and made according to an exclusive Tensolite process. New wire made by this process embodies all physical and electrical characteristics provided by other methods of Teflon insulating, and includes Color Guard Striping for identification; minimum continuous lengths of 250 feet are guaranteed; average production lengths run between 750 and 1000 feet; meets Mil-W-16878B for hook-up wire; thin and extra-thin walls to customer specifications.—*Tensolite Insulated Wire Co., Inc.*, 198 *Main St., Tarrytown, N. Y.*

For more information circle **390** on inquiry card.

Servo-Ratio Multimeter

New instrument for testing analog computers measures ac-dc ratios, absolute ac-dc voltages, and resistance. The gain of operational amplifiers also can be measured using the 0° phase output provided.



Voltage ratios are computed by dividing the voltage to be measured by the reference voltage obtained from the computer. Accomplished by the motor-driven servo mechanism shown in Fig. 1, simplification and reliability are assured by the use of printed circuits. (*From new* 8*-page bulletin, PD* 2005, *Union Switch and Signal Div., Westinghouse Air Brake Co., Pittsburgh* 18, Pa.)

For this literature circle **105** on inquiry card.

Fans

Axivane fans, series 1000, available for use in naval vessels, electronic instruments, aircraft etc., are built around the motor to economize on power, labor and space. Servicing is ordinarily limited to lubrication. Adjustable blades can be quickly changed to

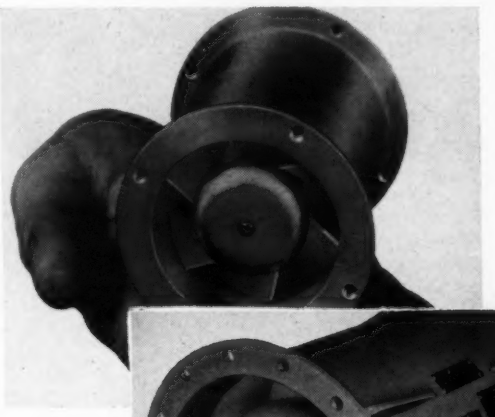


Fig. 1. Electronic equipment fan.

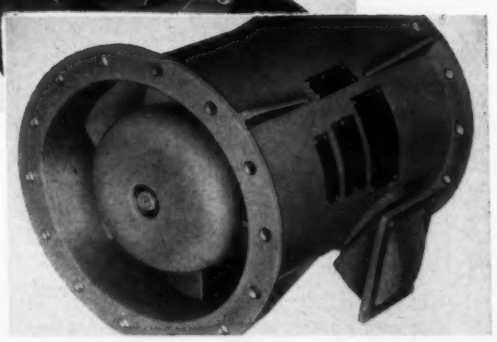


Fig. 2. Marine type fan.

provide either a wide pressure-range or a change in volume. A permanent stop prevents setting blades in a position which would overload the motor. Fans can be installed in any position without risk of damage and are compact and light-weight. (*From* 16*-page bulletin J-611, Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh* 22, *Pa.*)

For this literature circle **106** on inquiry card.

HIGH RELIABILITY

DC/AC CHOPPERS

- ADVANCED DESIGN
- HIGH STABILITY
- LONG-LIFE

New and advanced designs by Collins Electronics Manufacturing Corporation now make possible a series of precision miniature choppers unique in reliability, stability of operating characteristics and long service life.

This new series of choppers is manufactured in S.P.D.T. types in both break-before-make and make-before-break models. Make-before-break models are unique in that the force developed by the vibrating element is exerted to hold the working contacts closed rather than to hold the non-working contacts open as in conventional designs. This results in firm contact closure, high contact pressure and imperviousness to disturbances caused by shock and vibration.

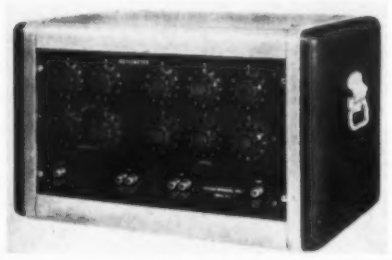
Write today for detailed brochure listing all types available with applicable technical information.

COLLINS
ELECTRONICS
MANUFACTURING CORP.
Stevensville, Maryland

For more information circle **31** on inquiry card.

AC RATIOMETER

New models measure ac voltage ratios between 0.000001 and 1.111111, provide overall frequency range of from 40 cps to 2000 cps and are said to be accurate to 5 parts per million.



Used for testing precision transformers, resistors, capacitors and inductors used in critical circuitry, ratiometers use an ac bridge circuit with a variable transformer in the balance arm of the circuit. A transistorized amplifier provides gain to feed the null signal directly to the deflection plates of an external oscilloscope giving null indication and direct-reading indication of quadrature voltage injection.—*Transformers Inc.*, 200 *Stage Rd., Vestal, N. Y.*

For more information circle **391** on inquiry card.

ALPHA-BETA METER

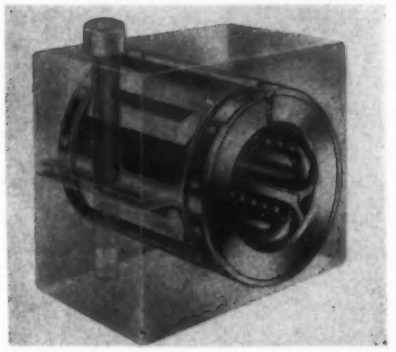
New transistorized radiological survey meter for personnel and site monitoring of alpha and beta radiation, dosage, spillage, and contamination is for use in shipyards, Hot Labs., reactor installations, and nuclear ships.

The detecting element is a thin end mica window, halogen-quenched GM tube with a 1.4-2 mg/cm² window thickness, mounted in an external probe. Sensitivity ranges have values of 0.5, 5.0, and 50 mr/hr. Operates over 150 hours from two standard 1½v "D"-sized flashlight cells, employs transistorized power supply.—*Universal Transistor Products Corp.*, 143 *E. 49th St., New York* 17, *N. Y.*

For more information circle **392** on inquiry card.

ADJUSTABLE DIAMETER LINEAR BEARING

New adjustable diameter ball bushings are split longitudinally and are designed to easily provide line-to-line or slight preload fits when mounted in an adjustable diameter housing.

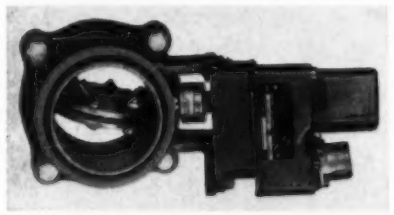


Available in standard sizes for shaft diameters ranging from 1" to 4".—*Thomson Industries Inc., Manhasset, N. Y.*

For more information circle **393** on inquiry card.

FUEL VALVE

Designed for aviation fuels systems at ambients from −65° F to +265°C new line mounted butterfly-type valve meets MIL-V-6808 (ASG). 2½" line



unit weighs 3.2 lbs, may be controlled electrically, hydraulically, pneumatically or manually.—*Aero Supply Mfg. Co. Inc., Corry, Penna.*

For more information circle **394** on inquiry card.

FLOW METERING SYSTEM

New inexpensive electronic liquid and gaseous flow measuring system utilizes electrical signals proportional

to flow rate and accumulated flow. Its computer features magnetic amplifiers, silicon diodes and transistors; has no moving parts. Accuracy within 1% of full-scale output with 20% or more flow; long-term accuracy 0.25%. Speed of response 0.03 sec for 63.2% of full-scale change. Totalized volume, registered on mechanical counter, can also be recorded on strip chart used to record flow rate.—*Computers, Inc.*, 2025 *Harold St., Houston* 6, *Texas.*

For more information circle **395** on inquiry card.

MA

ELECTRONIC COMPONENTS

AIRBORNE COMPONENTS (accelerometers, pressure transducers, gyros, temperature probes, and vane transducers) are described and specs given in 56-page catalog.—G. M. Giannini & Co. Inc., Pasadena, Calif.

Circle **401** on inquiry card.

BUILDING BLOCKS, New 6-page bulletin describes characteristics of plug-in transistorized printed circuits of digital system elements.—Comptron Corp., 778 Pleasant St., Belmont 79, Mass.

Circle **402** on inquiry card.

PACKAGED ELECTRONIC CIRCUITS schematics and listings are subject of 12-page Guide No. 4.—Centralab Div., Globe Union Inc., 900 Keefe Ave., Milwaukee 4, Wis.

Circle **403** on inquiry card.

PRINTED CIRCUITS for custom production with technical data, are described in 8-page booklet.—Litton Industries Components Div., 5873 Rodeo Rd., Los Angeles 16, Calif.

Circle **404** on inquiry card.

SERVO AMPLIFIERS for controlling 1/50 to ¾ hp ac or dc motors shown in 2-page leaflet.—Magnetic Research Corp., 3160 W. El Segundo Blvd., Hawthorne, Calif.

Circle **405** on inquiry card.

ELECTRICALLY VARIABLE inductors, ferrite core, permanent magnet bias, for 1 to 200 mc are subject of bulletin 10/57.—Vari-L Co., Inc., 432 Fairfield Ave., Stamford, Conn.

Circle **406** on inquiry card.

TRANSISTOR AMPLIFIERS, 28vdc are described with diagrams and characteristics in new 4-page brochure.—M. Ten Bosch, Pleasantville, N. Y.

Circle **407** on inquiry card.

SATURABLE REACTOR applications are described with diagrams and formulas in new 32-page application guide.—Barber-Colman Co., Rockford, Ill.

Circle **408** on inquiry card.

SAT FORMER, a variable auto transformer for ac power-control operating like magnetic amplifier, is described in bulletin 101.—McHenry Control Corp., P. O. Box 604, Norwalk, Conn.

Circle **409** on inquiry card.

TELEMETERING OSCILLATOR, miniaturized and battery powered, described in leaflet—Dorsett Labs. Inc., 401 E. Boyd St., Box 862, Norman, Okla.

Circle **410** on inquiry card.

TIME DELAY RELAYS and program switches meeting mil-specs are described in new 4-page Bulletin EDS No. 5.—Automatic Timing & Controls, Inc., King of Prussia, Penna.

Circle **411** on inquiry card.

DELAY LINES, 0.1 to 6.0 microseconds, are described in 2-page data sheet.—Valor Electronics Co., 13214 Crenshaw Blvd., Gardena, Calif.

Circle **412** on inquiry card.

DIPPED MICA CAPACITORS with radial leads and meeting MIL-C-5A specs are described in new 2-page bulletin #242B1.1. —Aerovox Corp., New Bedford, Mass.

Circle **413** on inquiry card.

SUBMIN. CERAMIC CAPACITORS are subject of new bulletin G-1.—Mucon Corp., 9 St. Francis St., Newark 5, N. J.

Circle **414** on inquiry card.

POWER SUPPLIES for computer aircraft and military applications are described in 6-page brochure GEA-6690. —General Electric Co., Rectifier Dept., Lynchburg, Va.

Circle **415** on inquiry card.

TECHNICAL SUPPLY CATALOG, new 16-page #65 just released.—Lectronic Research Labs., 715 Arch St., Phila. 6, Pa.

Circle **416** on inquiry card.

ELECTRONIC COMPONENTS are listed in 360-page catalog No. 68.—Newark Electric Co., 223 W. Madison St., Chicago 6, Ill.

Circle **417** on inquiry card.

ELECTRONIC INSTRUMENTS

AIRBORNE INSTRUMENTS and custom-design facilities are subject of 4-page brochure.—Burton Mfg. Co., Colorado Ave. at 26th St., Santa Monica, Calif.

Circle **418** on inquiry card.

AIRBORNE FLOWMETER systems are described in new spec. sheet AF-1.—Potter Aeronautical Corp., 3898 Linden Ave., Route 22, Union, N. J.

Circle **419** on inquiry card.

ALTITUDE/AIRSPEED portable test set, for flight line testing of altimeters, airspeed indicators, mach meters, etc. is described with specs in 8-page bulletin #442.—Norden-Ketay Corp., Commerce Rd., Stamford, Conn.

Circle **420** on inquiry card.

MOMENT-OF-INERTIA measurement for potentiometers is discussed in technical bulletin #20: non-linear loading error in technical bulletin #10.—TIC of California, 7229 Atoll Ave., N. Hollywood, Calif.

Circle **421** on inquiry card.

RADAR TEST SETS and lab instruments covering Lp to V frequencies are described in 8-page bulletin.—Microwave Electronics Div., Sperry Gyroscope Co., Div. of Sperry Rand Corp., Great Neck, N. Y.

Circle **422** on inquiry card.

SPECTRUM ANALYZER, 32 cycle is described in new 8-page bulletin 2-521.—Raytheon Mfg. Co., Hartwell Rd., Bedford, Mass.

Circle **423** on inquiry card.

PEAK VOLTAGE COMPARATOR, model 700, ac/ac, ac/dc with digital readout is described in 2-page bulletin RR 1002.—Cal-Tronics Corp., 11307 Hindry Ave., Los Angeles 45, Calif.

Circle **424** on inquiry card.

TIME-RATE INDICATOR measuring time, rate, total or ratio of recurrent events, explained in 4-page bulletin, #501A-B.—Laboratory for Electronics Inc., 75 Pitts St., Boston 14, Mass.

Circle **425** on inquiry card.

DATA LOGGING equipment, digital, is described in 4-page folder.—General Automation, 701 West Broadway, Glendale 4, Calif.

Circle **426** on inquiry card.

SYNCHRO BRIDGE MEASUREMENT of synchro and resolver errors in accordance with mil-specs is explained in 12-page technical bulletin.—Theta Instrument Corp., 48 Pine Street, East Paterson, N. J.

Circle **427** on inquiry card.

PHASE-SENSITIVE DETECTOR applications for high performance servos and specs. are described in new 4-page bulletin.—The Emerson Electric Mfg. Co., 8100 W. Florissant Ave., St. Louis 21, Mo.

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SERVO DIGITIZER, SL-1004 driven by 400 cps ac data is described with specs in 2-page release.—Industrial Control Co., Wyandanch, L. I., N. Y.

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CHROMATOGRAM SCANNER which reads radioactive chromatogram strips with output to strip chart recorder is described with component units in bulletin #84.—Tracerlab, Inc., 1601 Trapelo Rd., Waltham 54, Mass.

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TUBE TESTER which checks grid-circuit, dynamic Gm and cathode emission checks is described, with schematics, in new 6-page data sheet.—Seco Mfg. Co., 5015 Penn Ave. S., Minneapolis 19, Minn.

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GYROS, MOTORS

RESOLVER. Bu Ord MK 4 mod 1, size 15, is described with specs. in 2-page bulletin #438.—Norden-Ketay Corp., Commerce Rd., Stamford, Conn.

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SERVOMOTOR model SM 460, for 115 v, 400 c supply is described in 2-page Data Sheet #909.—Beckman/Helipot Corp., Newport Beach, Calif.

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SERVO MOTORS. New mil spec types and motor tachometer produced new in past year are described in 10-page bulletin.—Servomechanisms Inc., 625 Main St., Westbury, L. I., N. Y.

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DAMPER RATE GYRO, microsized, is subject of 3-page tech bulletin giving specs. and performance curves.—United States Time Corp., 346 Tejon Place, Palos Verdes, Calif.

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ANTENNAS, WAVEGUIDES

SATELLITE TRACKING ANTENNAS including diagrams, are discussed in 6-page bulletin 1613-S.—Technical Appliance Corp., Sherburne, N. Y.

Circle **436** on inquiry card.

MOBILE RADIO ANTENNAS, accessories and towers for 2-way communications are described, with specs, in new 40-page catalog #457.—Communication Products Co. Inc., Marlboro, N. J.

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PARABOLIC UHF ANTENNAS: eleven sizes from 4′ to 32′ diameter are each described in separate 2-page leaflet—Technical Appliance Corp., Sherburne, N. Y.

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ANTENNA LIGHTNING ARRESTOR, AMC-127, for use in operational aircraft and meeting MIL-A-9094B (ASG) is described in Bulletin R-40. —Dale Products Inc., Box 136, Columbus, Neb.

Circle **439** on inquiry card.

TELEMETERING DIPLEXERS, type 1231, for coupling two 100w 215—250 mc transmitters into single antenna in test missiles and supersonic aircraft are subject of bulletin 1231.—Hycon Eastern Inc., 75 Cambridge Pwky., Cambridge 42, Mass.

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COAXIAL and WAVE GUIDE switches are described and engineering specs. given in 12-page technical bulletin.—Thomson Products Inc., Electronics Div., 2196 Clarkwood Rd., Cleveland 3, Ohio.

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TUBES, TRANSISTORS

SILICON GERMANIUM ALLOY DIODES said to combine high reverse resistance with fast transient response and high forward conductance at elevated temperatures are subject of technical bulletin B-215.—Clevite Transistor Prod., 241 Crescent St., Waltham 54, Mass.

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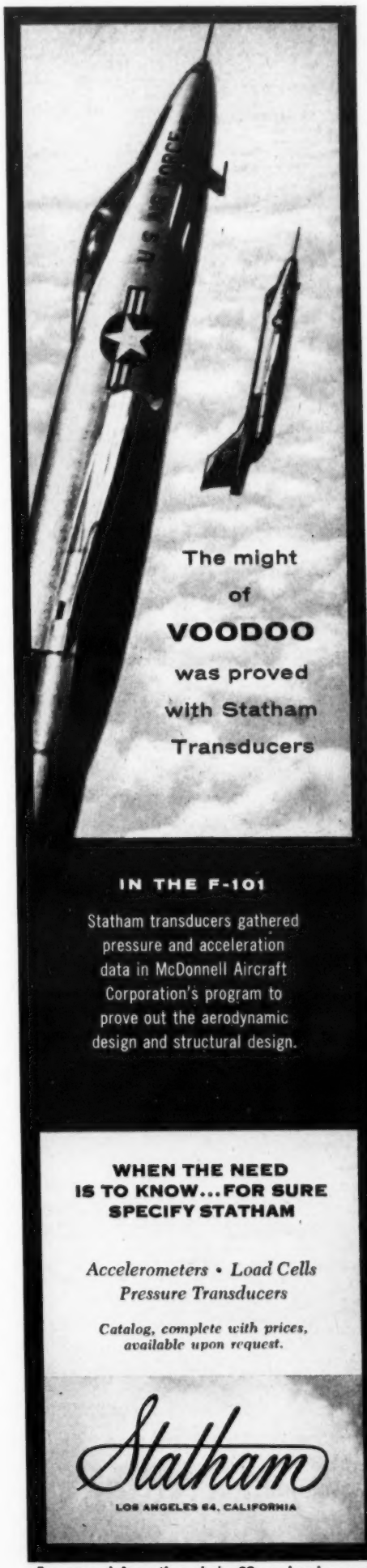
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GENERAL DATA

Electrical:

Minimum DC Collector-to-Base Voltage for dc collector current of −50 μamp with emitter open, and at ambient temperature of 25°C	−40	volts
Maximum DC Collector Current for dc collector-to-base voltage of −1 volt with emitter open, and at ambient temperature of 25°C	−10	μamp
Maximum DC Collector Current for dc collector-to-base voltage of −12 volts with emitter open, and at ambient temperature of 25°C	−16	μamp
Minimum DC Emitter-to-Base Voltage for dc emitter current of −50 μamp with collector open and at ambient temperature of 25°C	−0.5	volt

Mechanical:

Mounting Position	Any
Maximum Length (Excluding flexible leads)	0.405"
Maximum Diameter	0.240"
Case	Metal, Insulated
Envelope Seals	Hermetic
Leads, Flexible	4
Length	1.5" min.
Orientation and diameter	See Dimensional Outline

It is 0.240" in diameter and 0.405" in length. Impurity distribution is controlled to produce a built-in accelerating field. This field propels the charge carried from emitter to collector, thus reducing base resistance and collector-to-base capacitance. Shielding (connected to fourth lead) minimizes interlead capacitance and coupling to adjacent circuit components. This transistor can provide a power gain of 45 db at 1.5 mcs and 24 db at 10.7 mcs. (*From new 8-page technical bulletin, RCA, Semiconductor Div., Somerville, N. J.*)

For this literature circle **107** on inquiry card.

Precision Resistors

In Type M encapsulated wire wound types, low temperature coefficient alloys are aged to insure a long term stability of better than 0.01%. Reversed and balanced windings provide negligible phase shift to 20 kc. Terminals are rigid 0.018" brass hot solder coated, and operating temperatures are from −65°C. to +145°C.

MIL-R-93A & MIL-R-9444 TEMPERATURE COEFFICIENT

SYMBOL	EXPRESSED IN PERCENT PER DEGREE C
E	±0.003
J	0.013 +0.002 −0.009
K	0.017 +0.002 −0.004

(*Networks, precision power, meter multipliers, and deposited carbon resistors meeting Mil specs. are also described in 24-page brochure, Mepco Inc. 37 Abbett Ave., Morristown, N. J.*)

For this literature circle **108** on inquiry card.

SILICON ZENER DIODES specs. are described in new bulletin SR-155.—International Rectifier Corp., 1521 E. Grand, El Segundo, Calif.

Circle **443** on inquiry card.

HALF WAVE SILICON DIODES 35 vrms, 50 amp to 210 vrms, 20 amp are subject of new 4-page bulletin SR-143D.—International Rectifier Corp., 1521 E. Grand, El Segundo Calif.

Circle **444** on inquiry card.

HIGH-MU TWIN TRIODES. 9-pin min. types, 6DT8 and 12DT8, are subject of technical bulletin 12DT8.—R.C.A., Electron Tube Div., Harrison, N. J.

Circle **445** on inquiry card.

MULTIPLIER PHOTOTUBE #7046 is 14-stage, head-on type, with 4-$\frac{7}{16}$" dia. photocathode for nuclear measurement applications, described in 10-page technical bulletin.—R.C.A. Tube Div., Harrison, N. J.

Circle **446** on inquiry card.

MICROWAVE TUBE characteristics are listed in new 8-page data chart.—Raytheon Mfg. Co., Waltham 54, Mass.

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FACILITIES & ENVIRONMENTAL TESTS

ACOUSTICS, laboratory, standards and Environmental testing are subjects of facilities bulletins IL-1, IL-2, and EL-1 respectively.—Bell Aircraft Corp., P. O. Box 1, Buffalo 5, N. Y.

Circle **448** on inquiry card.

ELECTRONIC TRENDS and developments are discussed in new 20-page "New World of Electronics" facilities brochure.—Amphenol Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.

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WEAPONS SYSTEMS management thru computation is discussed in 32-page facilities brochure.—Burroughs Corp., Detroit 32, Mich.

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PORTABLE HYDRAULIC POWER PACKS for aircraft line testing are described in 4-page bulletin HP-200.—Greer Hydraulics Inc., New York International Airport, Jamaica 30, N. Y.

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AIRCRAFT HYDRAULIC and engine test equipment is described in 16-page bulletin #253.—Sprague Engineering Corp., 19300 S. Vermont Ave., Gardena, Calif.

Circle **452** on inquiry card.

PUNCHED TAPE data storage equipment used in integrated data processing are explained in 24-page booklet.—Friden Calculating Machine Co. Inc., 1 Leighton Ave., Rochester 2, N. Y.

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DRY SCREEN process equipment for manufacture of printed circuits is subject of 12-page booklet.—Edward M. Power Co. Inc., Bessemer Bldg. Pittsburgh 22, Pa.

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PROGRAMMED CENTRIFUGE (rocket simulator) for component testing is described in new 14-page brochure.—The Magnavox Co., 2131 Bueter Rd., Fort Wayne 4, Ind.

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SEMI CONDUCTOR, UHF and phototube applications are stressed in 36-page facilities brochure of the RCA Electronic Components Organization—Electron Tube Div. RCA, Harrison, N. J.

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MISCELLANEOUS

TRANSISTORIZED AUTOMATIC PILOT for maintaining three-directional control is featured in new 4-page bulletin No. 119.—Mitchell Industries Inc., Mineral Wells, Texas.

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CAPSWITCH POSITION INDICATOR for providing check on valve functions in remote or complex operations with specs., is subject of 2-page bulletin.—Robertshaw-Fulton Controls Co., Bridgeport Thermostat Div., Milford, Conn.

Circle **458** on inquiry card.

MAGNETIC TAPE for Instrumentation described in leaflet #3594.—Ampex Corp., 934 Charter St., Redwood City, Calif.

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STAINLESS STEEL specification chart SEC A, No 2 shows chemical analysis requirements for frequently used Military and Government specifications.—Peter A. Frasse & Co. Inc., 17 Grand St., New York 13, N. Y.

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THERMOSTAT METAL, nonmagnetic Truflex S125, is subject of bulletin TRU-4.—Metals & Controls Corp., Attleboro, Mass.

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MAGNETIC SHIELDS for 7 and 9 pin vacuum tubes are described in Data sheet #132.—Perfection Mica Co., Magnetic Shield Div., 1322 N. Elston Ave., Chicago 22, Ill.

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CLAMPS for retention and cooling of tubes and components are described in Kool Klamp catalog #5-KK.—Birtcher Corp, 4371 Valley Blvd., Los Angeles 32, Calif.

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SLEEVING and **TUBING** described with Mil. Specs. and cross reference in catalog 55-T.—Birnbach Radio Co., Inc., 145 Hudson St., New York 13, N. Y.

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HYPERSIL Type "C" cores for transformers and magnetic reactors are described with data charts in illus. 24-page booklet.—Westinghouse Electric Corp., P. O. Box 2099, Pgh. 30, Pa.

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AN CONNECTOR specifications drawings of hermetic seal glass-to-metal sockets are given in 16-page catalog #657 C.—Hermetic Seal Corp., 29 S. Sixth St., Newark 7, N. J.

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FIBERGLASS molded battery containers are described in 1-page bulletin.—Resdel Corp., P. O. Box 217, Wildwood, N. J.

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SOLID FILM LUBRICANT (corrosion resistant) is subject of 2-page technical bulletin.—Electrofilm Inc. 7116 Laurel Canyon Blvd., N. Hollywood, Calif.

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SUB-MIN THERMOSTATS for fire detection, tube protection, etc. are subject of new 4-page descriptive folder.—Chatham Controls Corp., 33 River Rd., Chatham, N. J.

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DC MILLIVOLTMETER, model 216A specifications are discussed in new 2-page leaflet.—Industrial Control Co., 805 Albin Ave., Lindenhurst, L. I., N. Y.

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DC DIGITAL VOLTMETER model 401 is subject of 2-page data sheet.—Kin Tel, Box 623, San Diego 12, Calif.

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X-BAND RADAR TEST SET combining functions of freq meter, power meter, signal generator, spectrum analyzer and synchroscope is described with specs. in 4-page bulletin B1X.—Sperry Gyroscope Co., Microwave Electronics Div., Great Neck, L. I., N. Y.

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	B1167	6" x 7⅛"	Electrostatic	Electromagnetic	12 KV	10"
	B1194	3" x 1½"	Electrostatic	Electromagnetic	16 KV	10½"
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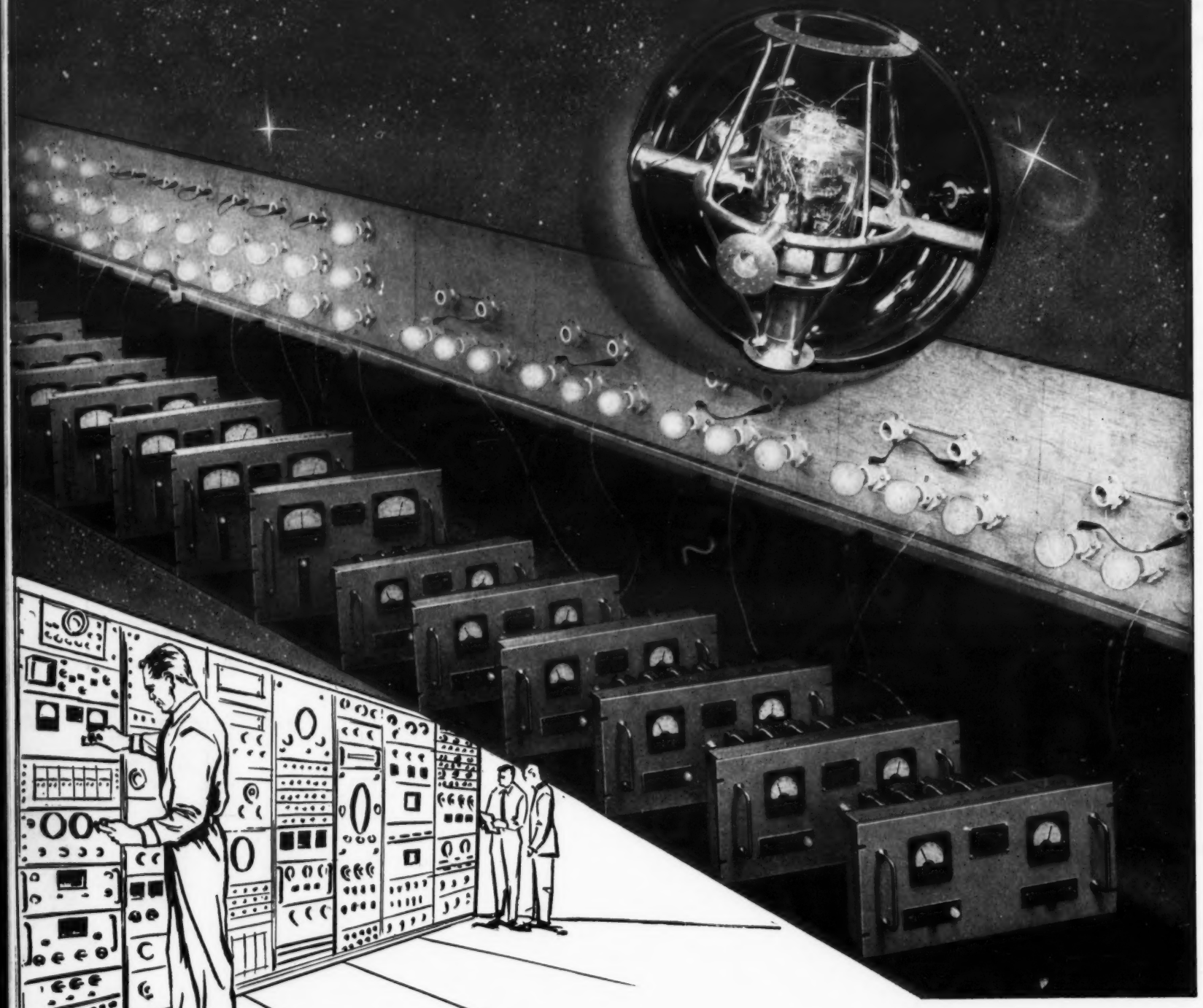

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